# RASCAL TRAINING

Unit 1 – Introduction & Walkthrough

# RASCAL Trainers


## George Athey

**Athey Consulting**

## Jeff Kowalczik, CHP

**US NRC**

**Office of Nuclear Security and Incident Response**

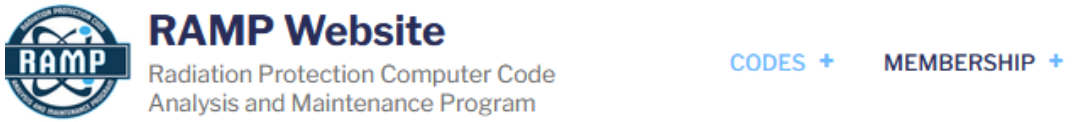
## Ed Harvey

**US NRC**

**Office of Research**

# RASCAL Support at RAMP.NRC-GATEWAY.GOV

- RAMP is NRC's program that manages several NRC technical tools
- An account is needed to access RAMP
  - Requires Non-Disclosure Agreement (NDA)
  - Free for Fed/State/Local gov
- Site Contents Include:
  - Code distribution (Download)
  - Technical documentation
  - Training Materials
  - FAQs
- For general and account issues: RAMP@nrc.gov
- For RASCAL-specific issues: RASCAL_Help@nrc.gov



# SOME RASCAL TRAINING IS ONLINE: RAMP.NRC-GATEWAY.GOV

e Menu

SCAL Overview

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Module 1 - Intro to RASCAL

Module 2 - Fundamentals

Module 3 - Tutorials

Qs

quest Support

## RASCAL Training & Presentation Materials

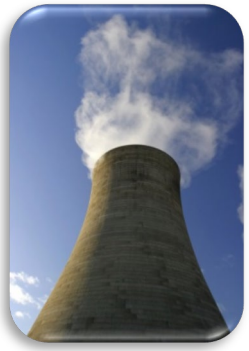
### Self-Study Training

This content provides introductory and refresher material for new and existing users.

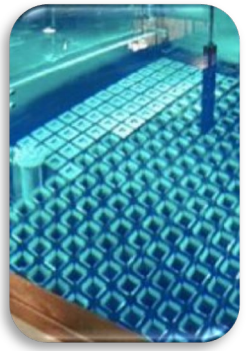
| COURSE | DESCRIPTION | AUDIENCE |
|---|---|---|
| Module 1: Introduction to RASCAL (16:58 minutes) | Brief overview providing general information on RASCAL. | New users, managers, and decision-makers. |
| Module 2: RASCAL Fundamentals (80:30 minutes) | An in-depth course covering how to use RASCAL and the models and methods within. | New users. |
| Module 3: RASCAL Tutorials | Instructional PDFs. Self-paced walkthroughs for a variety of topical areas practicing RASCAL. | New users and refresh for existing users. |

| | NAME | SIZE | DESCRIPTION |
|---|---|---|---|
| | 301 | 446.32 KB | Nuclear Power Plant: Loss of C |
| | 302 | 451.19 KB | Nuclear Power Plant: Long Ter |
| | 303 | 365.92 KB | Nuclear Power Plant: Coolant R Rupture (SGTR). (July 2017) |
| | 306 | 448.33 KB | Nuclear Power Plant: Containm |
| | 307 | 361.6 KB | Nuclear Power Plant: Release T Release by Mixtures. (July 2017 |
| | 331 | 436.9 KB | Spent Fuel Pool: Pool Storage – |
| | 351 | 432.55 KB | Other Radioactive Material Rele Described in the RASCAL Datal 2017) |
| | 361 | 516.75 KB | General Skills: Multiple Unit/So |
| | 362 | 522.55 KB | General Skills: Downloading We |
| | 363 | 594.07 KB | General Skills: Comparing RAS |
| | RASCAL-4.3.1-User-Guide | 20.46 MB | LEGACY USER GUIDE. Please r superseded by new RASCAL re |

# TECHNOLOGY REVIEW



**Nuclear Power Plant**



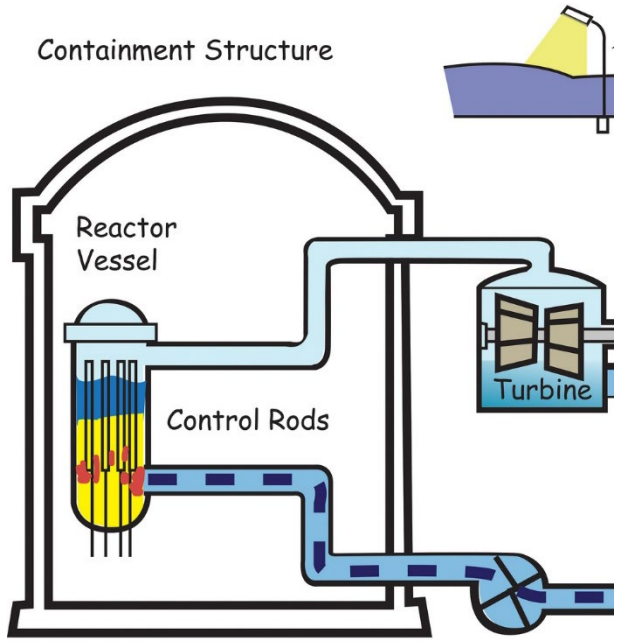
**Spent Fuel**

**Fuel Cycle**

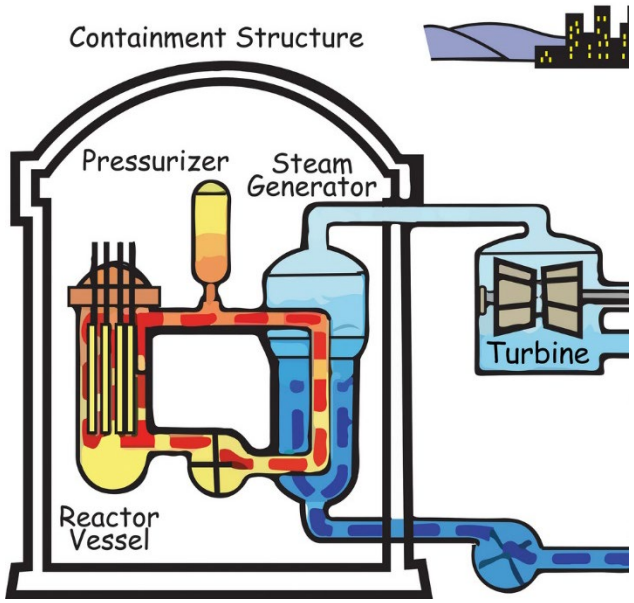
**Other Material**

# Reactor Types

**Core inside reactor vessel creates heat, steam is created (main loop in BWR, secondary loop in PWR), steam turns turbine, which produces electricity**



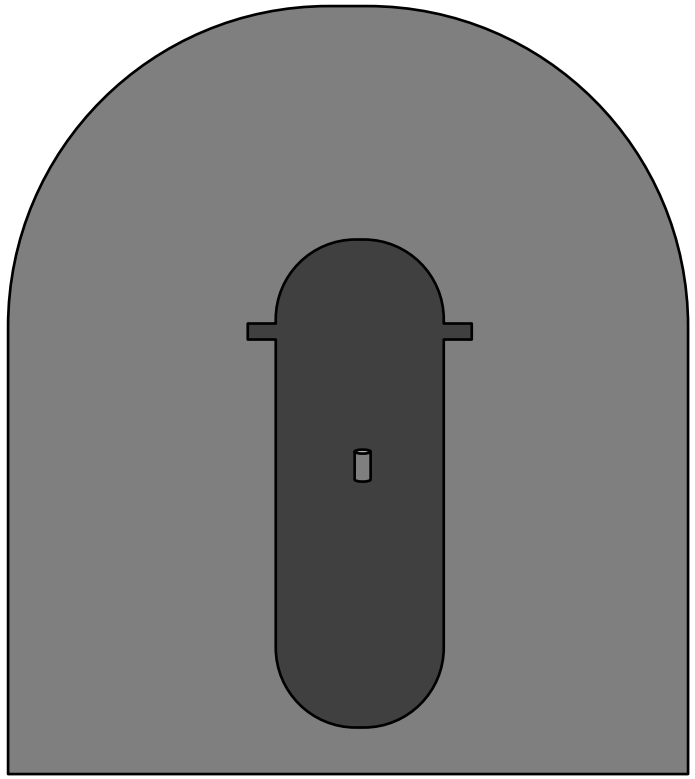

Boiling Water Reactor (BWR)




Pressurized Water Reactor (PWR)

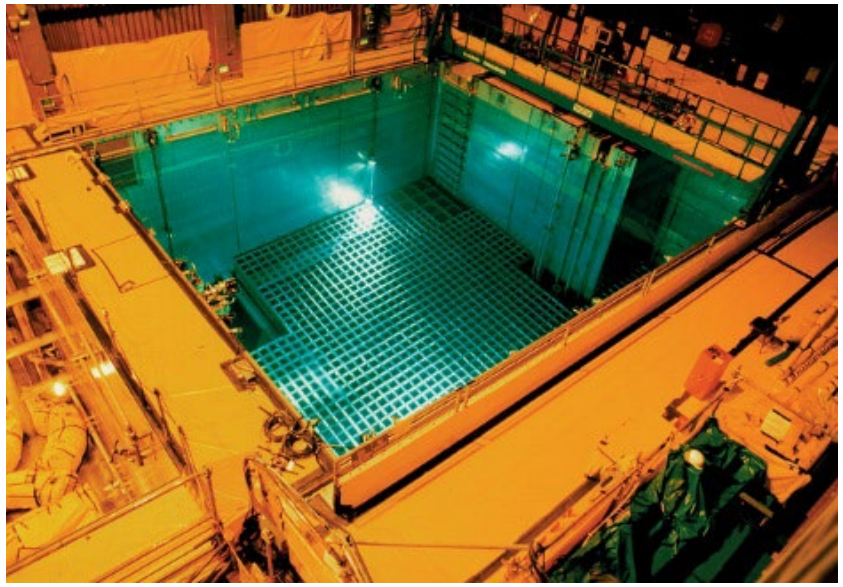
# LARGE RELEASES WILL COME FROM MAJOR FUEL DAMAGE, ONLY CAUSED FROM LACK OF COOLING

- No heat removal leads to fuel cladding failure and fuel melt
- Eventual RCS overpressure / leakage
- Possible containment overpressure / leakage



# Spent Fuel

- **Every 12-24 months, a fraction of reactor core is replaced and moved to a pool to cool.**
- **5-10 years later, cooler fuel moved to dry cask**



# Fuel Cycle

- Fuel cycle facilities convert, enrich, and fabricate mined material into reactor fuel
- RASCAL Supports these accident types:
  - $UF_6$ Cylinders
  - Criticality
  - Fire/Explosions involving Uranium Oxide

# Unit 1 Outline

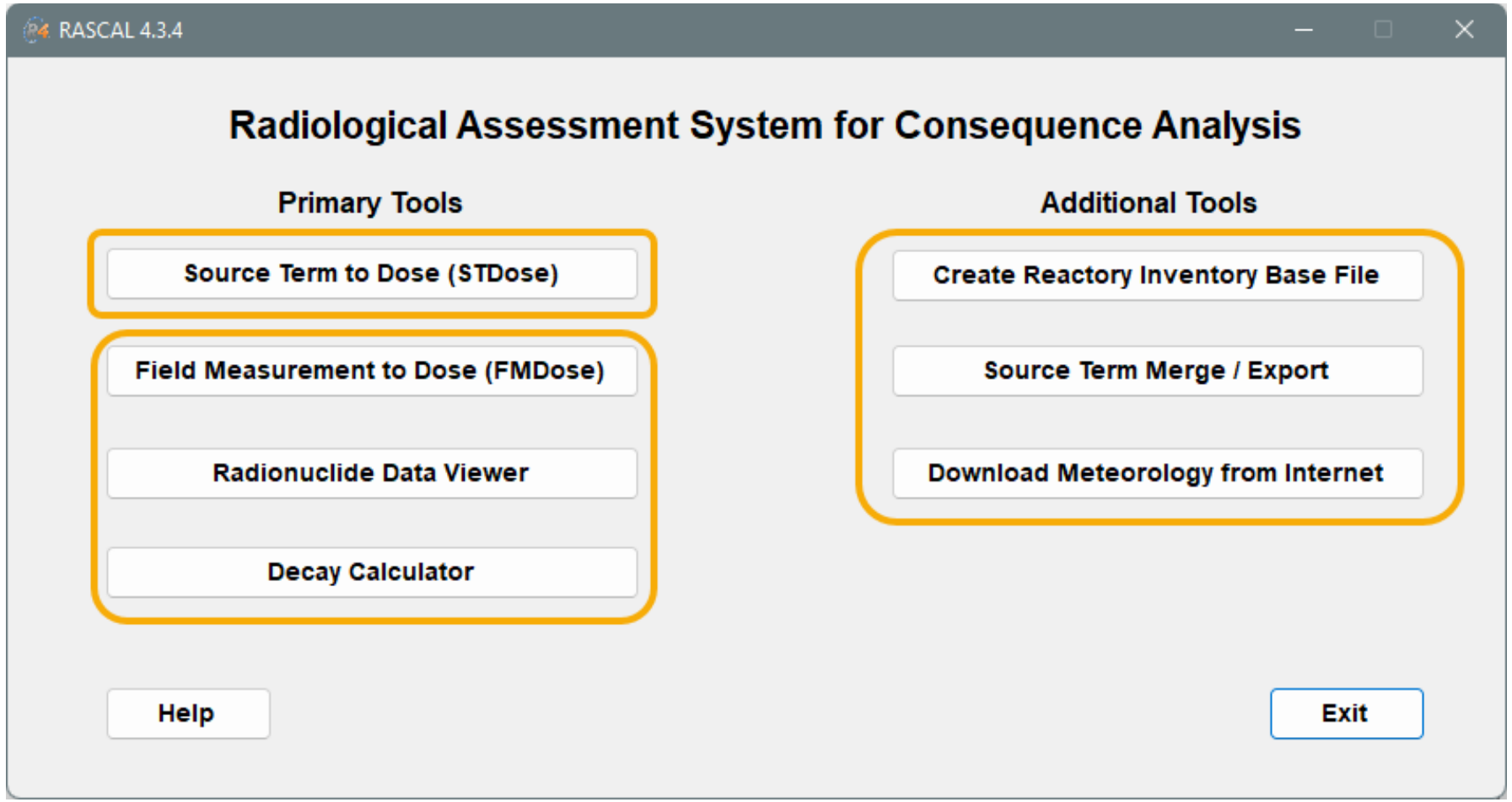
- **Walkthrough of using RASCAL STDose**
  - **Step by step discussion of screens and inputs**
  - **Familiarize users with STDose processes and software interface**

- ***Break in the middle of the session***

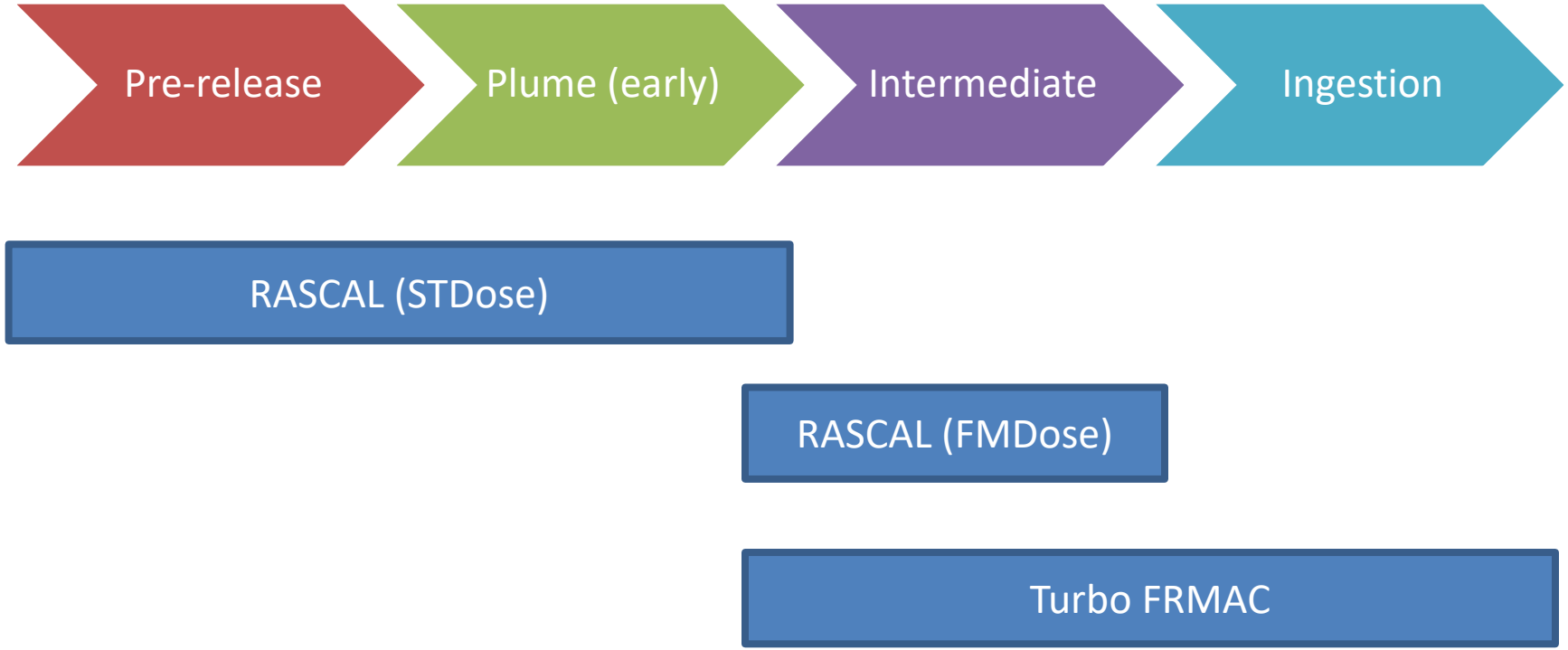
# RASCAL Slide

- **Every time we ask you to use RASCAL, you'll see one of these blue slides.**
- **It will include information needed to complete the steps.  Use this info instead of example screenshots (e.g., dates).**
- **Knowledge checks will be used to ask about the problem and make sure everyone is finished.**

# There are 4 primary tools and 3 additional tools on the RASCAL Home Page.

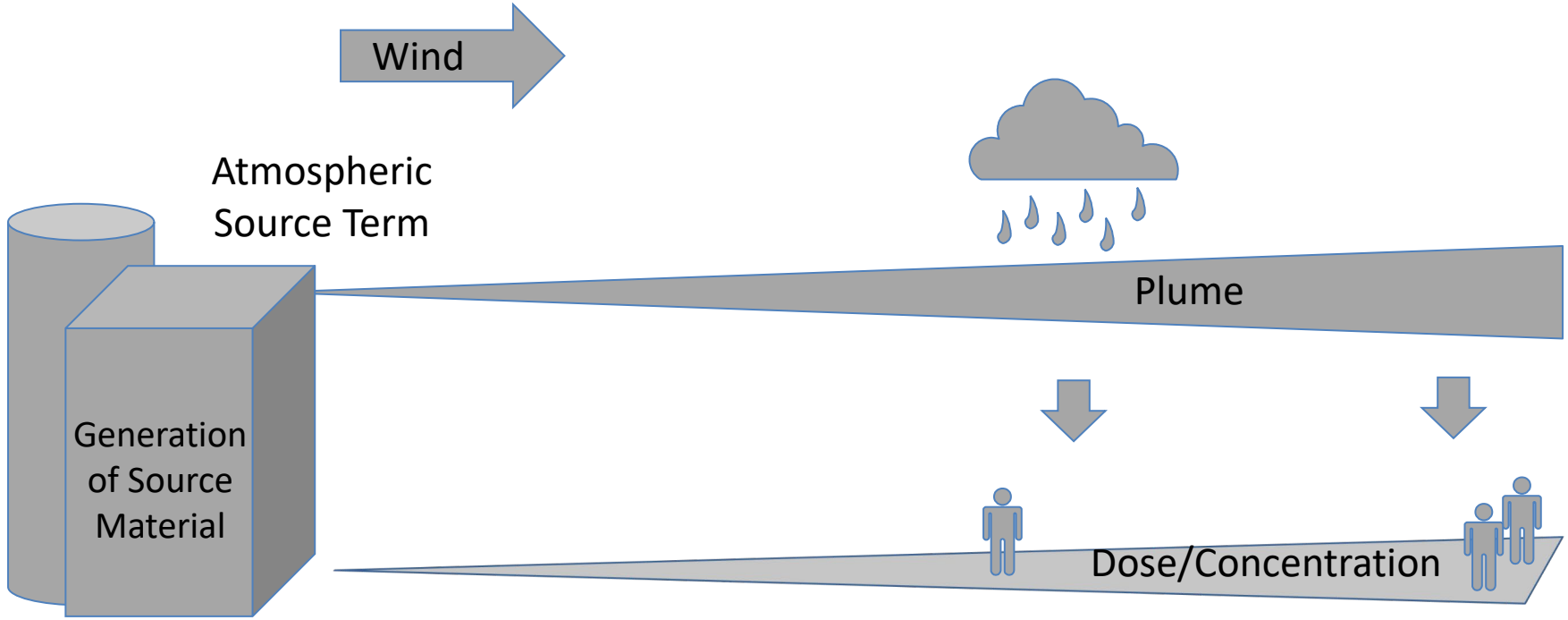


# WHERE DOES RASCAL FIT IN THE PHASES OF A RADIOLOGICAL EMERGENCY?



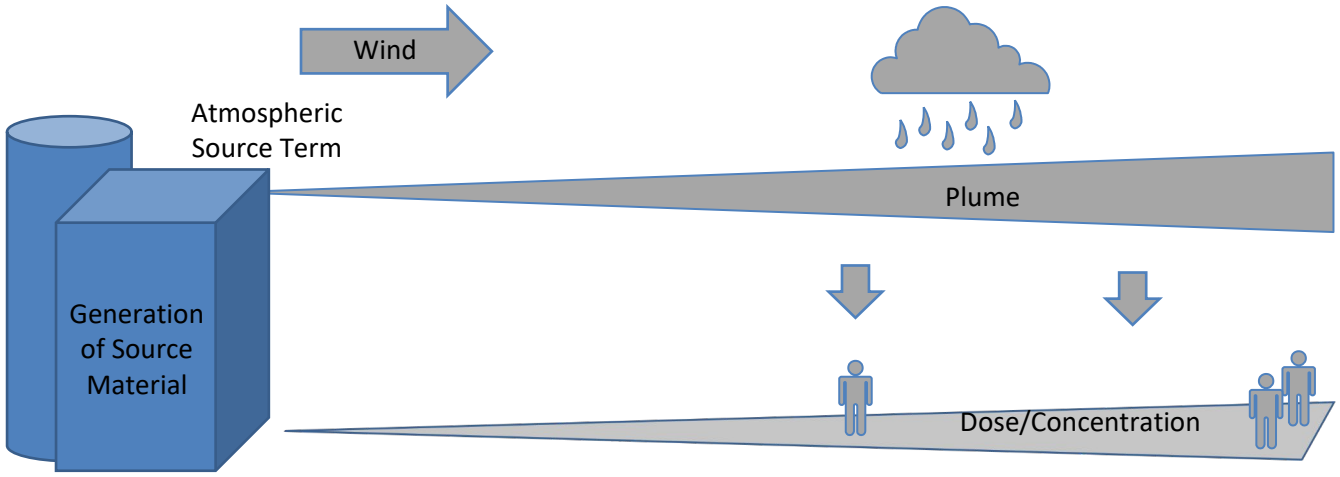
# Our Training Will Focus on STDose

**Source Term to Dose module creates an atmospheric source term, processes weather data, and calculates doses**



# RASCAL Defines Atmospheric Source Term

- Determines radionuclides available for release
  - May be single nuclide or complex core damage
  - Time-dependent isotopes and activity
- Source material may be filtered, reduced, or decayed

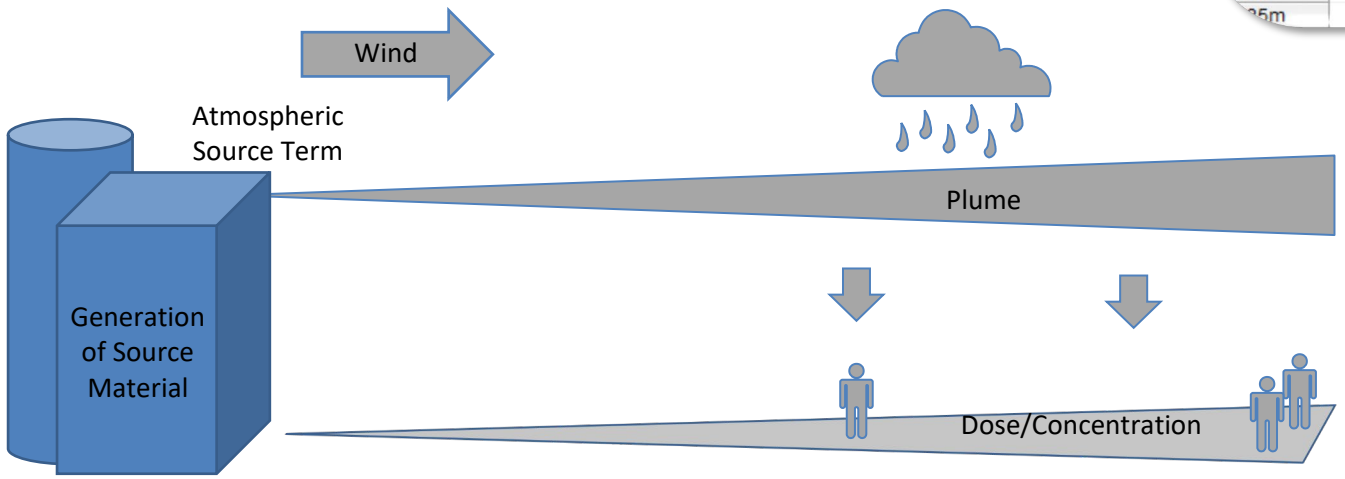


# Result is Radionuclides Released to Environment Over Time (Atmospheric Source Term)

## Isotopic activity over time (15 min)

...ity (Ci) released to atmosphere (by nuclide and time step)

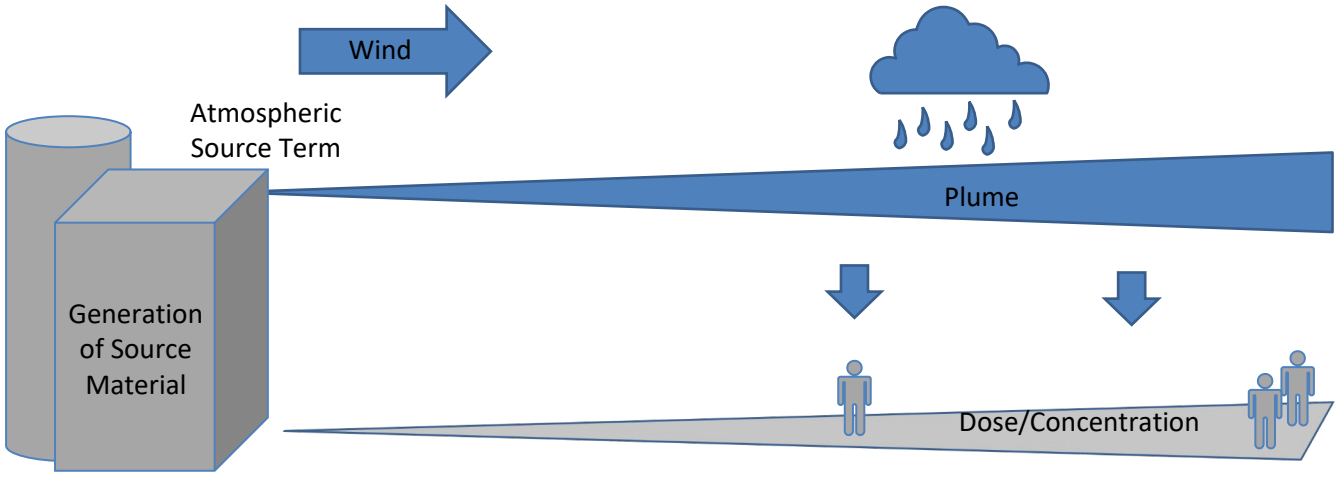
| Interval | 2016/02/02 | 2016/02/02 | 2016/02/02 | 2016/02/02 | 2016/02/02 | 2016/02/02 | 2016/02/02 | 20 |
|---|---|---|---|---|---|---|---|---|
| Start | 00:00 | 00:15 | 00:30 | 00:45 | 01:00 | 01:15 | 01:30 | 01: |
| Am-241 | 0.00E+00 | 0.00E+00 | 4.62E-10 | 1.46E-09 | 2.75E-09 | 4.17E-09 | 5.63E-09 | |
| Ba-139 | 0.00E+00 | 0.00E+00 | 5.62E+00 | 8.62E+00 | 9.99E+00 | 1.04E+01 | 1.02E+01 | 1 |
| Ba-140 | 0.00E+00 | 0.00E+00 | 7.25E+00 | 1.26E+01 | 1.66E+01 | 1.95E+01 | 2.17E+01 | 3 |
| Ce-141 | 0.00E+00 | 0.00E+00 | 1.67E-01 | 2.92E-01 | 3.83E-01 | 4.51E-01 | 5.01E-01 | 1 |
| Ce-143 | 0.00E+00 | 0.00E+00 | 1.51E-01 | 2.61E-01 | 3.42E-01 | 4.01E-01 | 4.43E-01 | 1 |
| Ce-144* | 0.00E+00 | 0.00E+00 | 1.35E-01 | 2.35E-01 | 3.09E-01 | 3.64E-01 | 4.04E-01 | 1 |
| Cm-242 | 0.00E+00 | 0.00E+00 | 1.71E-03 | 2.97E-03 | 3.91E-03 | 4.60E-03 | 5.11E-03 | |
| Cs-134 | 3.62E+00 | 6.30E+00 | 1.16E+01 | 1.56E+01 | 1.85E+01 | 2.07E+01 | 2.23E+01 | 2 |
| Cs-136 | 1.48E+00 | 2.57E+00 | 4.73E+00 | 6.35E+00 | 7.53E+00 | 8.41E+00 | 9.09E+00 | 9 |
| Cs-137* | 2.50E+00 | 4.36E+00 | 8.05E+00 | 1.08E+01 | 1.28E+01 | 1.43E+01 | 1.54E+01 | 1 |
| Cs-138 | 0.00E+00 | 1.73E+01 | 3.76E+01 | 5.65E+01 | 6.04E+01 | 5.41E+01 | 4.37E+01 | 3 |
| I-131 | 2.65E+01 | 4.60E+01 | 1.05E+02 | 1.49E+02 | 1.81E+02 | 2.05E+02 | 2.23E+02 | 2 |
| I-132 | 3.84E+01 | 6.49E+01 | 1.49E+02 | 2.07E+02 | 2.49E+02 | 2.81E+02 | 3.05E+02 | 2 |
| I-133 | 5.37E+01 | 9.27E+01 | 2.11E+02 | 2.95E+02 | 3.57E+02 | 4.01E+02 | 4.32E+02 | 4 |
| I-134 | 5.92E+01 | 8.46E+01 | 1.58E+02 | 1.85E+02 | 1.85E+02 | 1.72E+02 | 1.53E+02 | 1 |
| I-135 | 5.13E+01 | 8.70E+01 | 1.94E+02 | 2.67E+02 | 3.18E+02 | 3.50E+02 | 3.71E+02 | 3 |
| Kr-83m | 4.08E+00 | 7.43E+00 | 3.14E+01 | 5.10E+01 | 6.69E+01 | 7.94E+01 | 8.91E+01 | 8 |
| Kr-85 | 2.89E-01 | 5.78E-01 | 2.69E+00 | 4.81E+00 | 6.91E+00 | 9.00E+00 | 1.12E+01 | |
| ...5m | 8.25E+00 | 1.58E+01 | 7.11E+01 | 1.22E+02 | 1.69E+02 | 2.12E+02 | 2.52E+02 | |



# Atmospheric Source Term is Moved using ATD Models

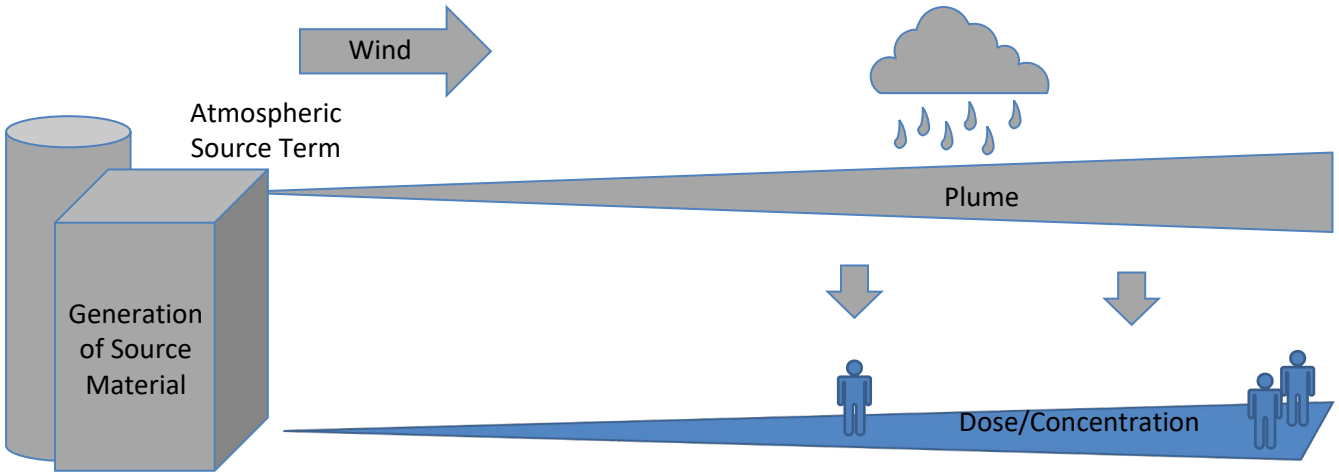
**Atmospheric Transport and Dispersion Models**

- **Transport material based on weather conditions**
- **Track material to where it falls/washes on ground**
- **Accounts for dry/wet processes and particle size**

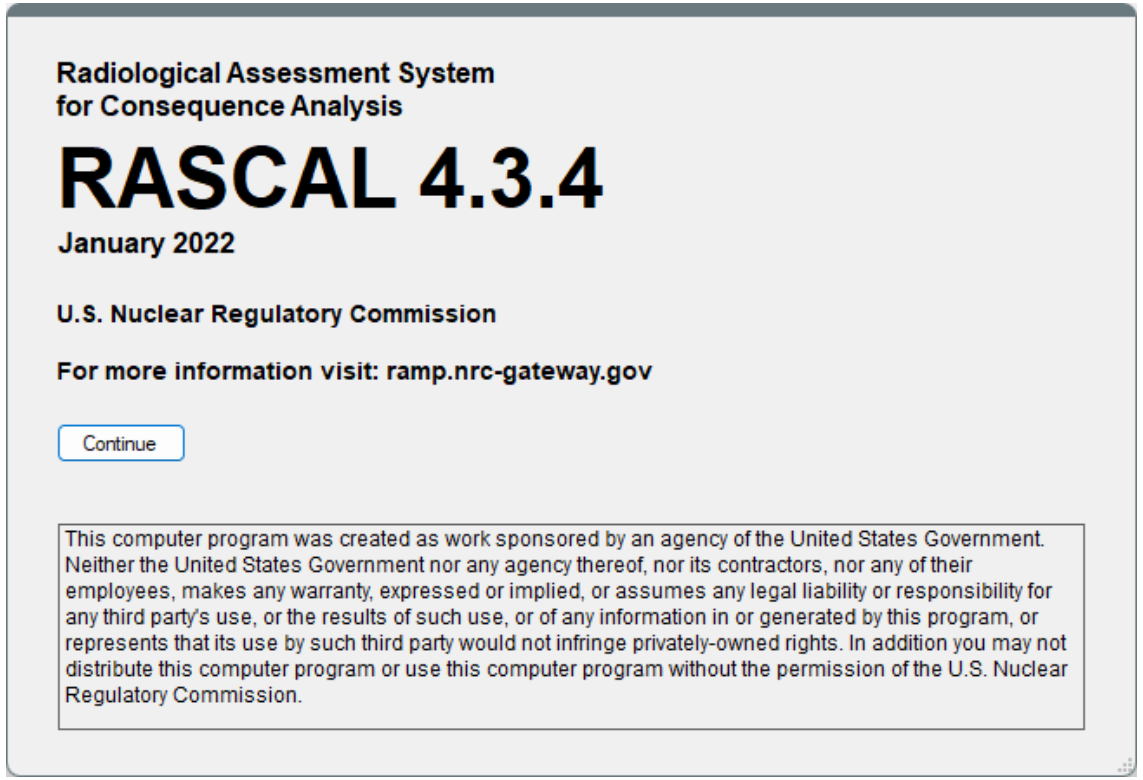


# Final Calculations Provide Doses and Concentrations over Calculation Area

- Dose calculation accounts for multiple pathways
  - External (Groundshine + cloudshine)
  - Internal (Inhalation + ~~ingestion)~~
- Results includes other display/calculation options



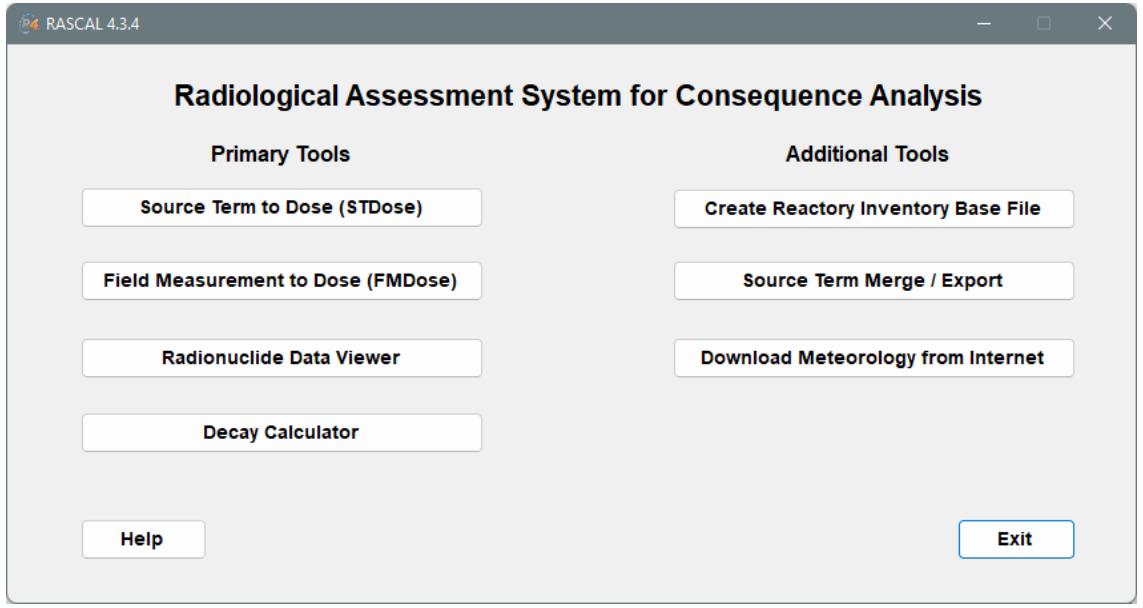
# WALKTHROUGH




Let's step through a RASCAL run together

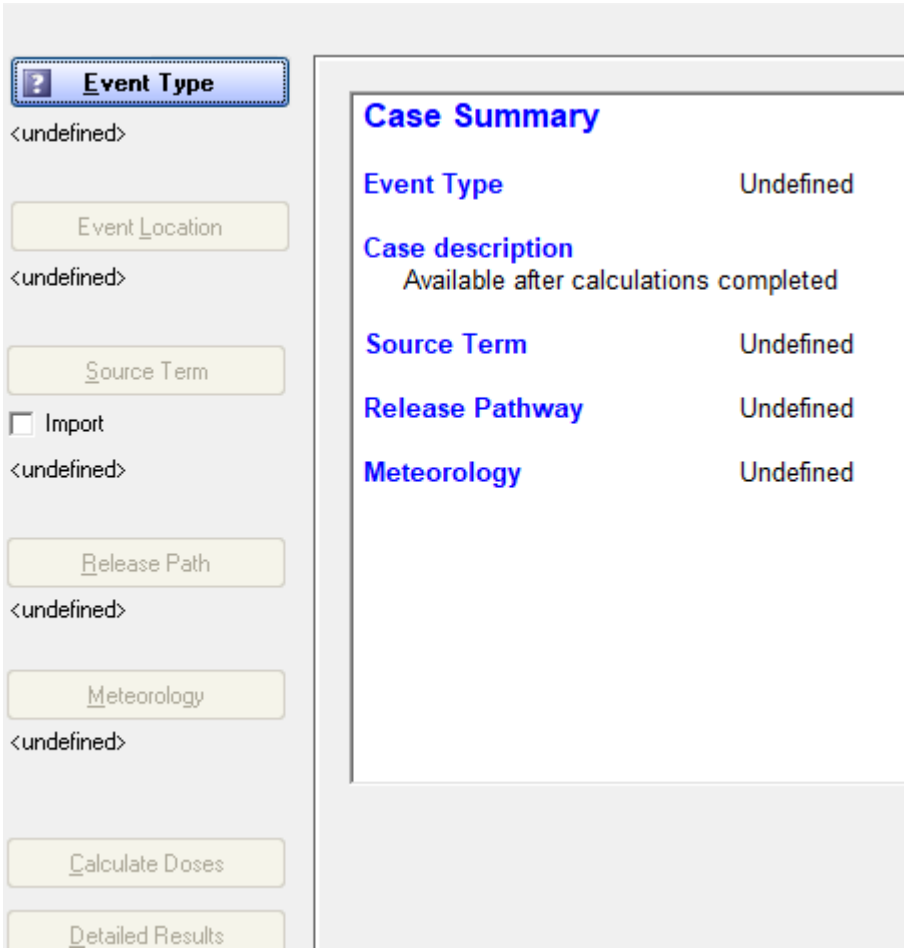
- Watch our discussion slides without using your RASCAL (screenshots may not match)
- At each blue slide, you will input information into RASCAL

# SELECT STDOSE



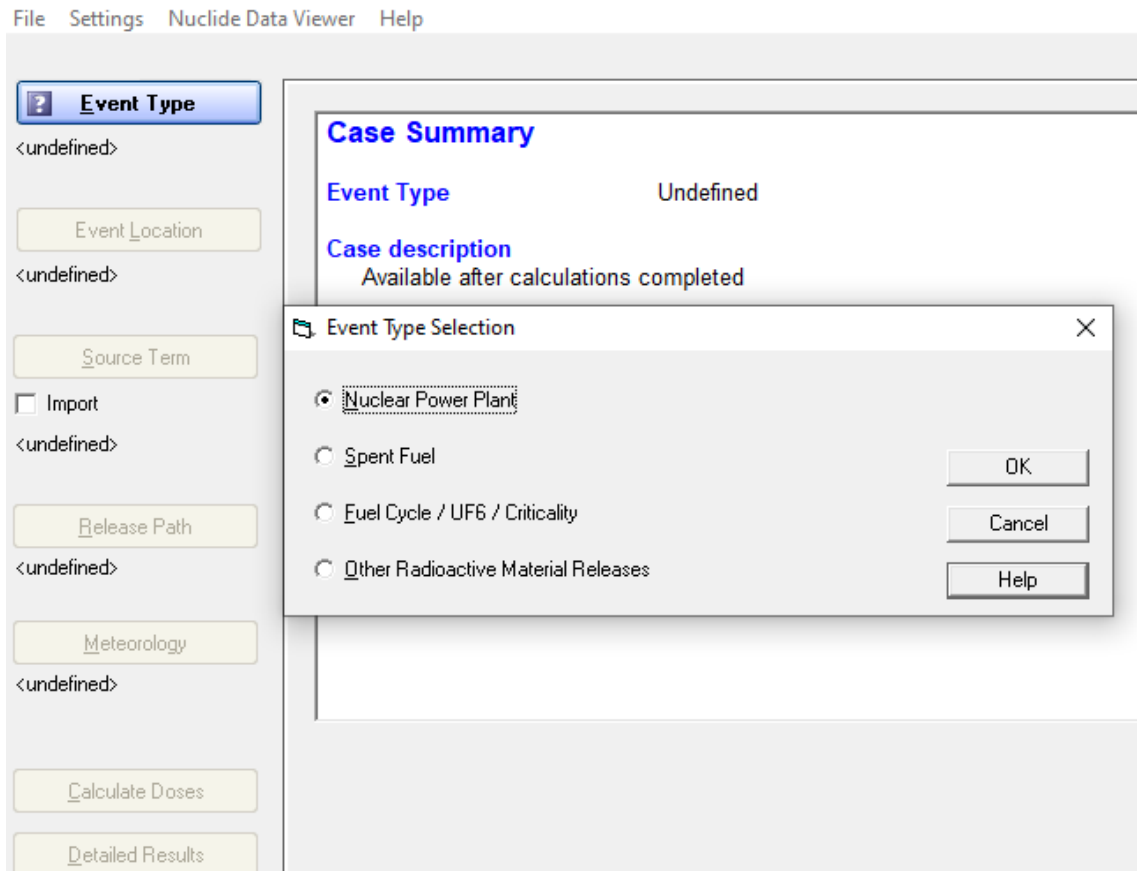

Most of what you will be using RASCAL for (dose assessment) will be done with Source Term to Dose (STDose).

# USING STDOSE




- Input information on the buttons on left, from top to bottom
  - Meteorology can be input once a location is selected
- Translate available data into RASCAL inputs
  - Some data is “static”; enter once
  - Some data is “dynamic” and changes with time as more communications is established and as conditions evolve

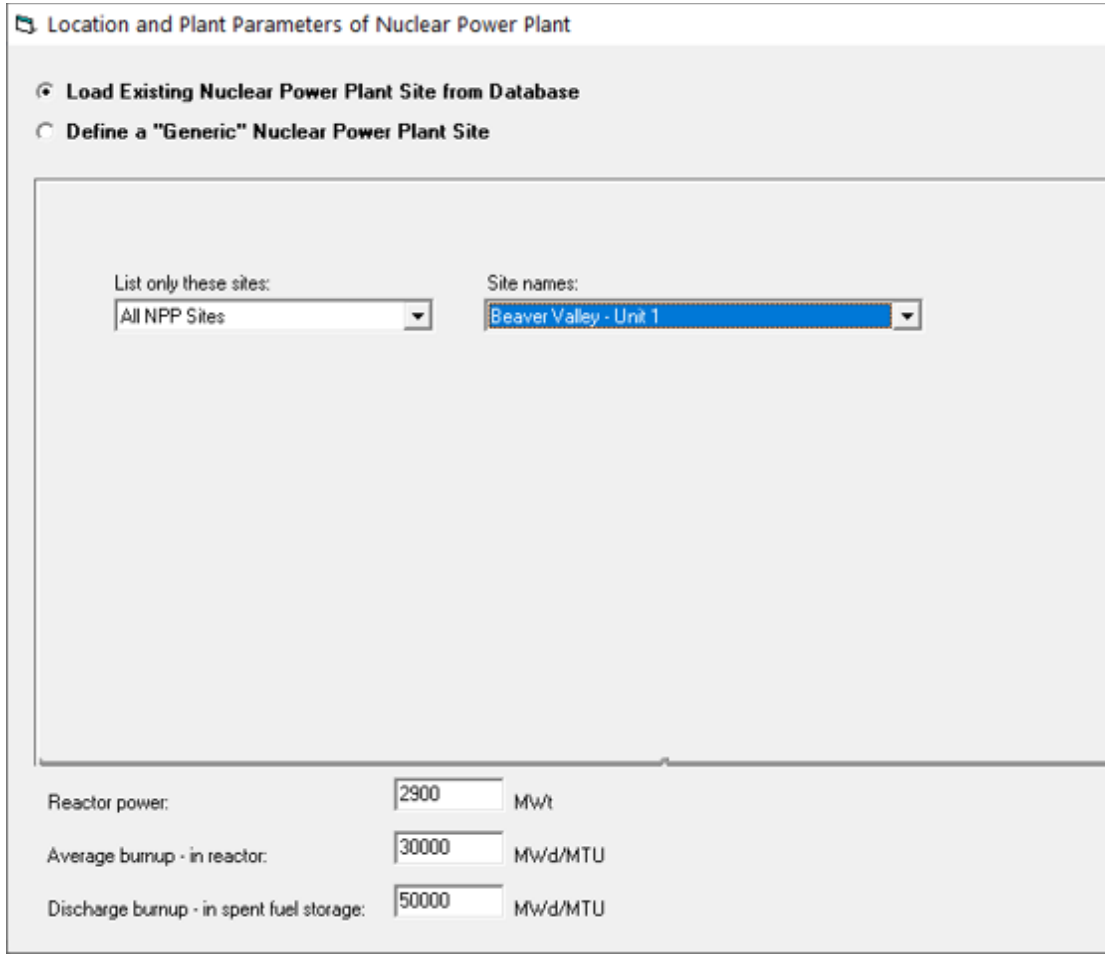
# START BY CLICKING EVENT TYPE




RASCAL breaks up locations and models into 4 types:

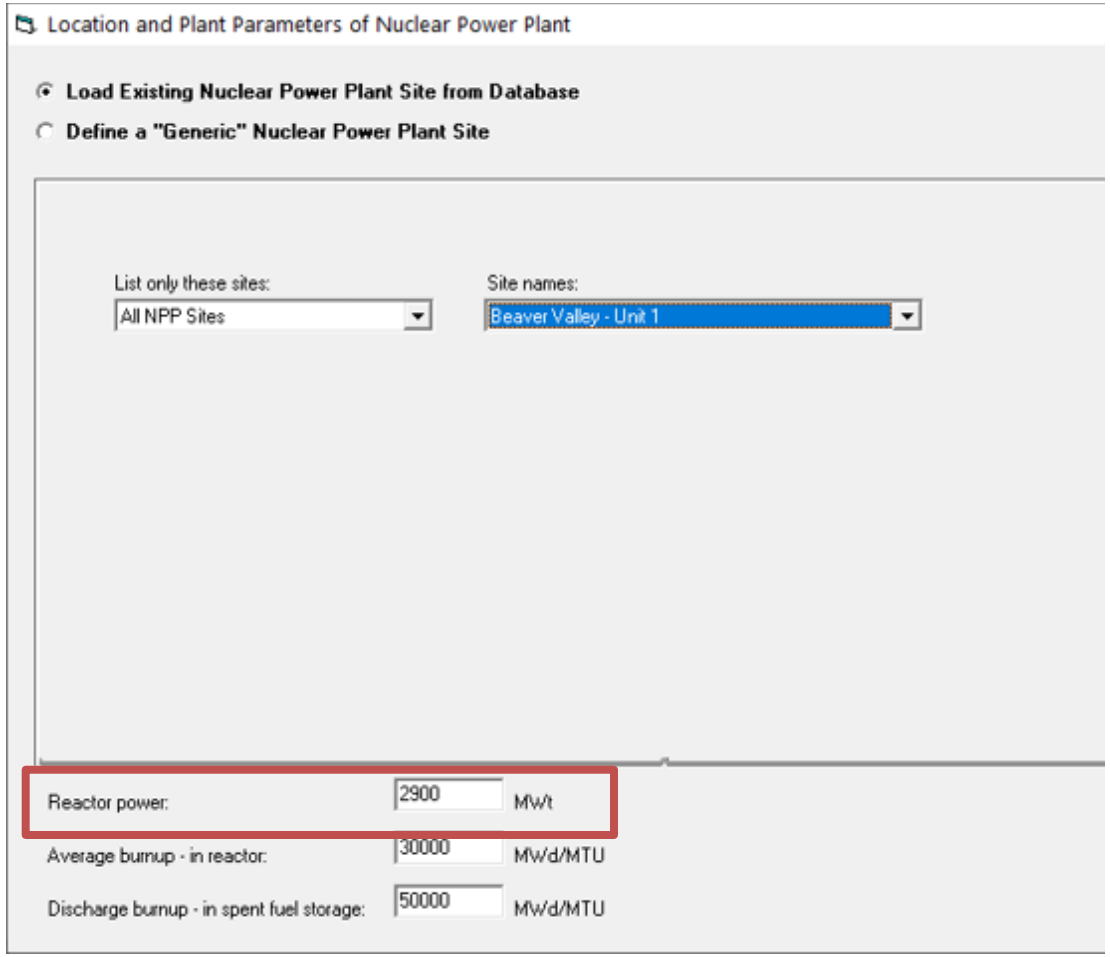
- Nuclear Power Plant
- Spent Fuel
- Fuel Cycle
- Other/Materials

# Next, Click Event Location



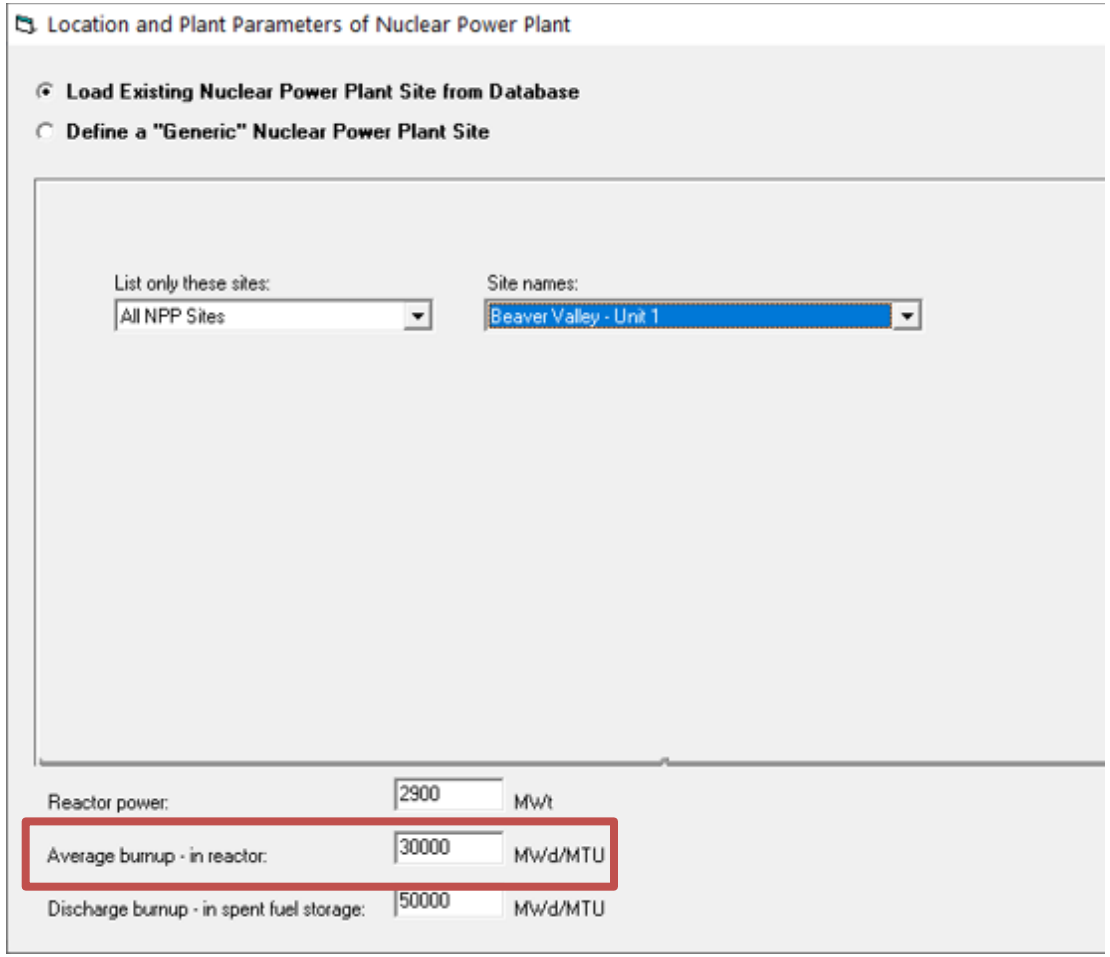

- Select from a list of predefined sites
  - All U.S. facilities (NPPs, Fuel Cycle, Materials)
  - International NPPs including: Canada, Mexico, South Africa, South Korea, Spain, Taiwan, Ukraine, and UAE
- Or, define a custom site
  - Need latitude/longitude coordinates
  - Does not build in roughness or topography

# At the Bottom of Location, Check Reactor Power




- Units of megawatts thermal (MWt) and is a direct measure of the energy produced by fission. This number is used by the model to determine the fission product inventory in the core.
- The facility database contains the power level at which the reactor is allowed to operate.
- Since reactors generally try to operate at 100% power, this value should rarely be changed.

# Also Check Burnup




- Fuel burnup has units of megawatt-days per metric ton of uranium (MWd/MTU) and is a measure of how much fission energy has been produced by the fuel elements that are currently in the core.
- RASCAL uses burnup to adjust core inventory for long-lived radionuclides in the core fuel. A mid-life core value is used as default instead of site-specific values
- If you have a burnup value – use it, otherwise the default is OK.

# Your Turn to Use RASCAL


- Start the RASCAL program & select STDose
- Click Event Type
  - Select Nuclear Power Plant
  - Click OK
- Click Event Location
  - Select Beaver Valley, Unit 1
  - Click OK

# LET'S WALK THROUGH TOGETHER

# Knowledge Check

The RASCAL STDose model supports which of the following radiological emergency phases? [select all that apply]

- Pre-release
- Plume (early)
- Intermediate
- Ingestion

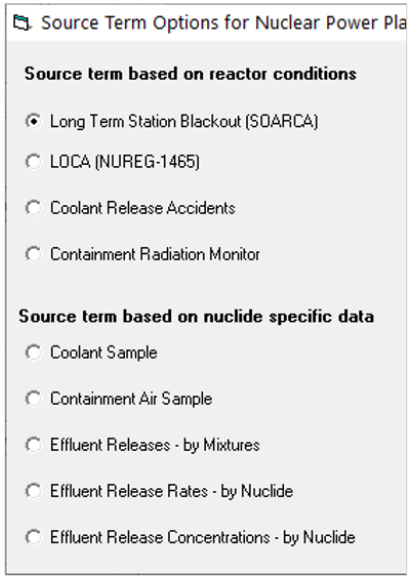
T or F, RASCAL can model releases from sites not in its facility database?

- True
- False

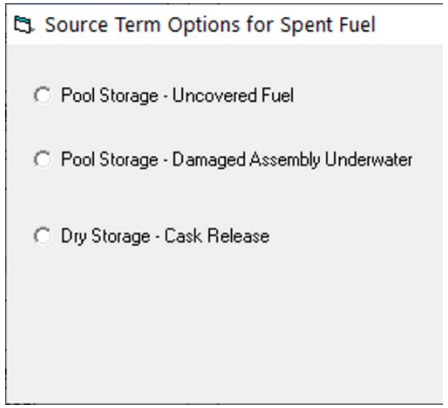
# Source Term

- Source term models calculate material that can be released
- Pick the best model; may have multiple options
- Available choices depend on Event Type

## Nuclear Power Plant

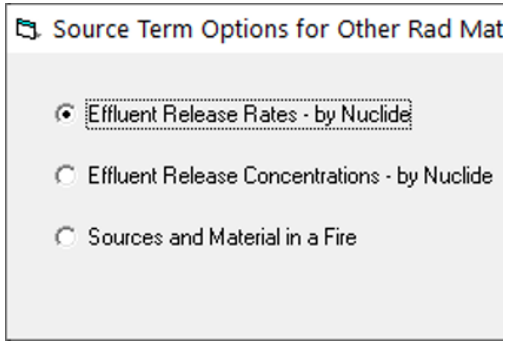



## Spent Fuel




## Fuel Cycle

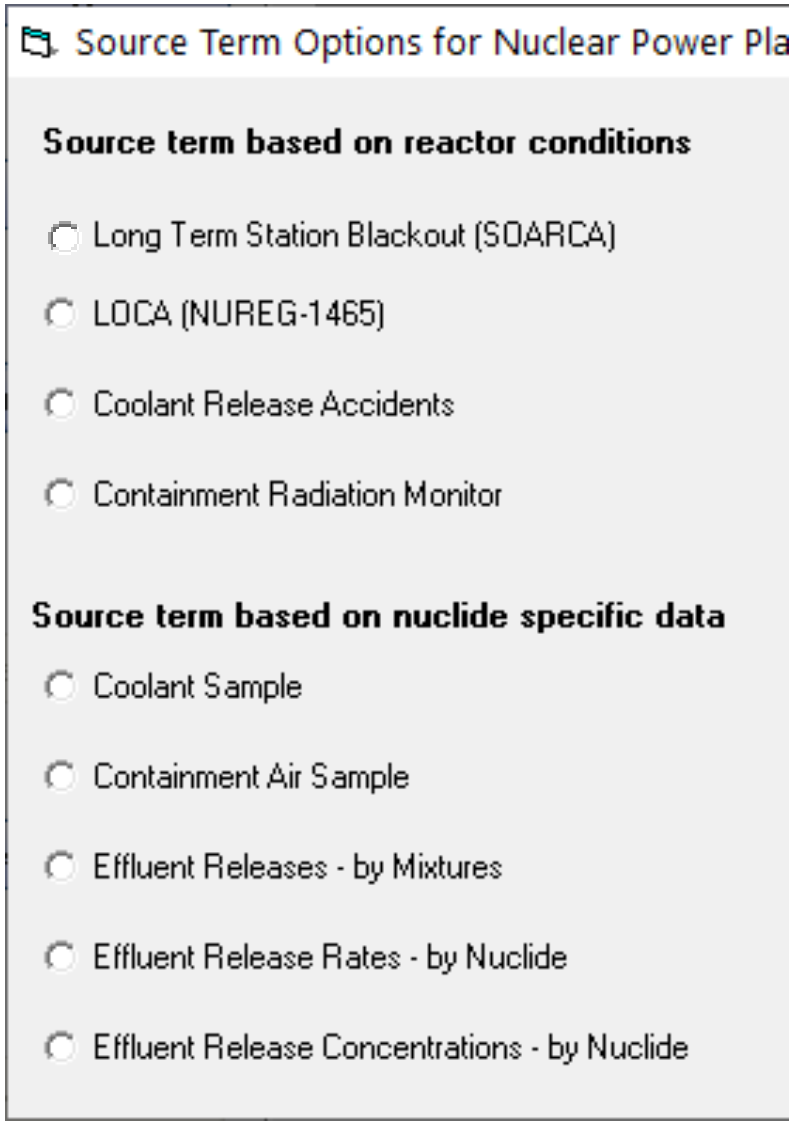

## Other Materials



Event Type

Source Term

# NUCLEAR POWER PLANT



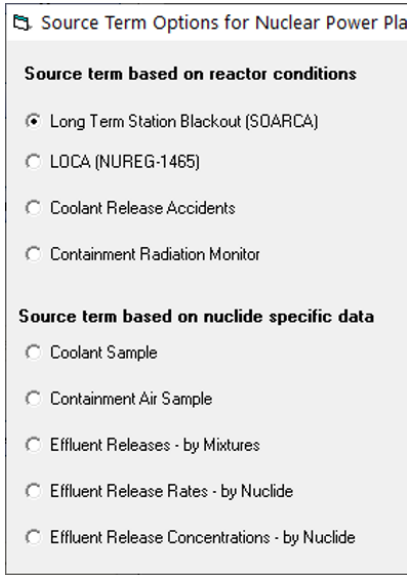

RASCAL has 9 nuclear power plant source term options:

- 4 based on reactor condition models
- 5 based on nuclide measurements

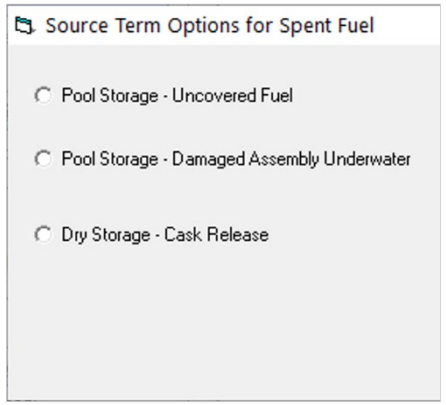
# Source Term

- Source term models calculate material that can be released
- Pick the best model; may have multiple options
- Available choices depend on Event Type

## Nuclear Power Plant

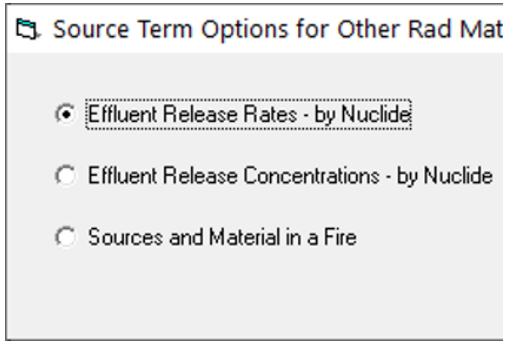



## Spent Fuel




## Fuel Cycle

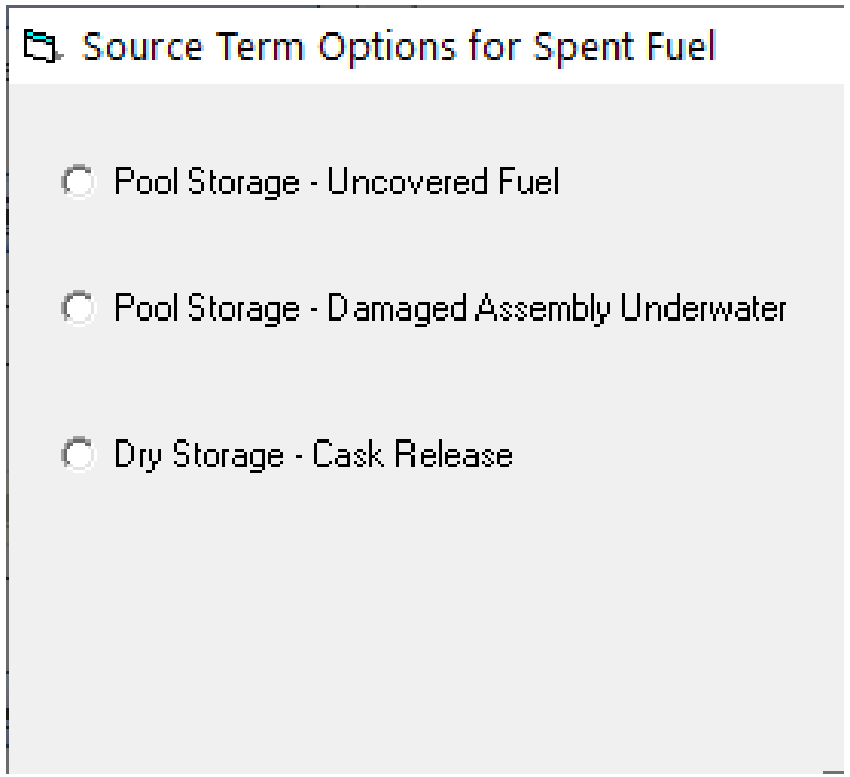

## Other Materials



Event Type

# SPENT FUEL

Source Term



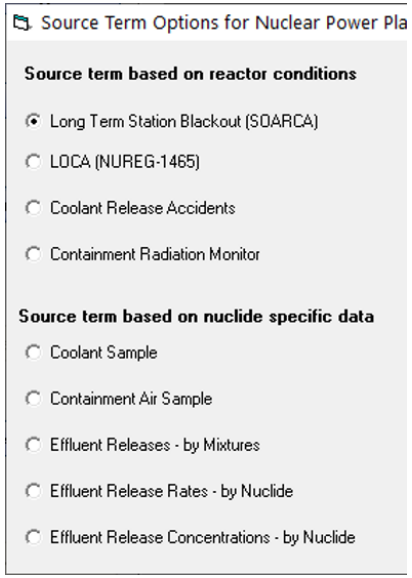

For Spent Fuel, RASCAL has 3 source term options

- Includes both pool and dry storage
- Sites are collocated with NPPs

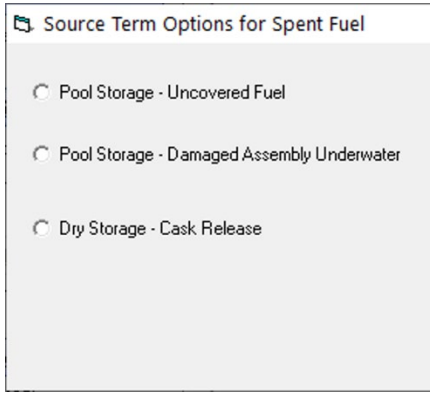
# Source Term

- Source term models calculate material that can be released
- Pick the best model; may have multiple options
- Available choices depend on Event Type

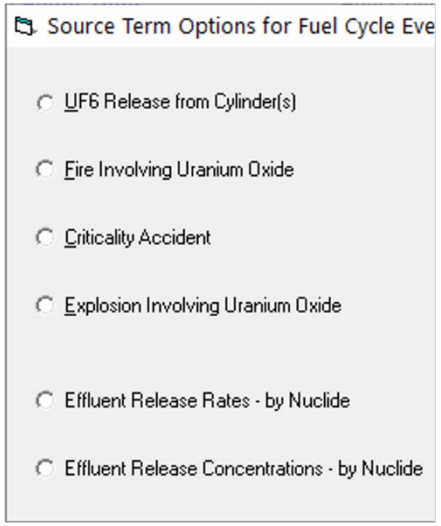
## Nuclear Power Plant



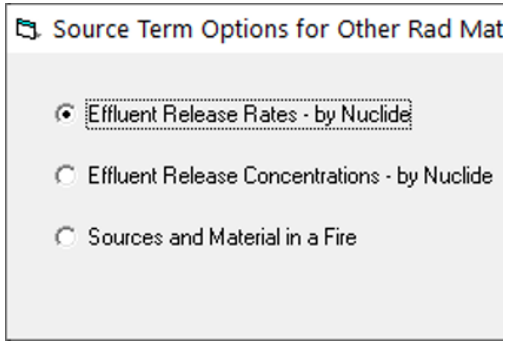

## Spent Fuel




## Fuel Cycle



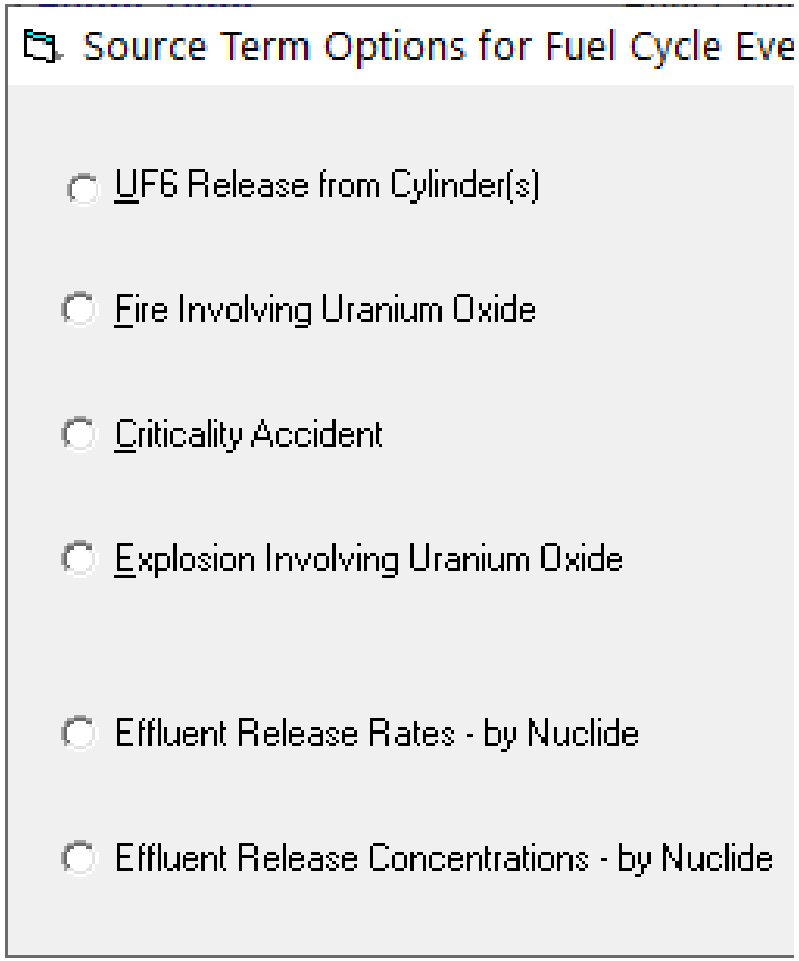

## Other Materials



Event Type

# FUEL CYCLE

Source Term

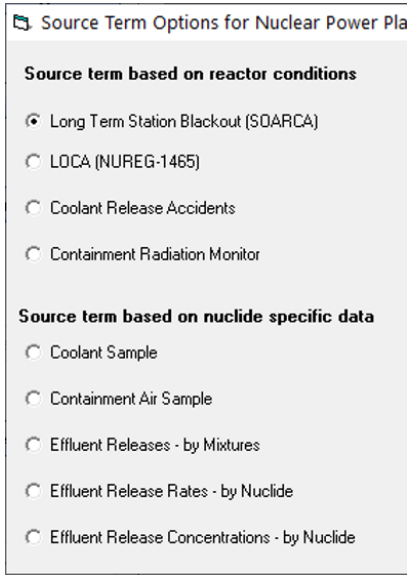



- RASCAL can model certain events from fuel fabrication facilities
  - UF6 chemical models
  - Criticality
  - UO2 Fire/Explosion

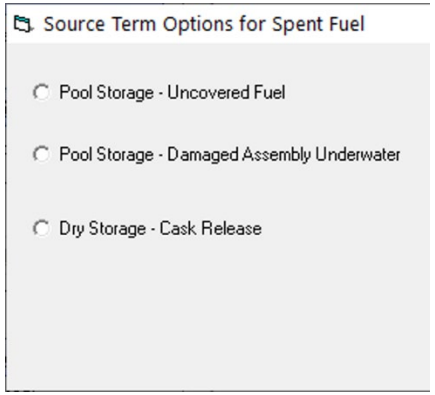
# Source Term

- Source term models calculate material that can be released
- Pick the best model; may have multiple options
- Available choices depend on Event Type

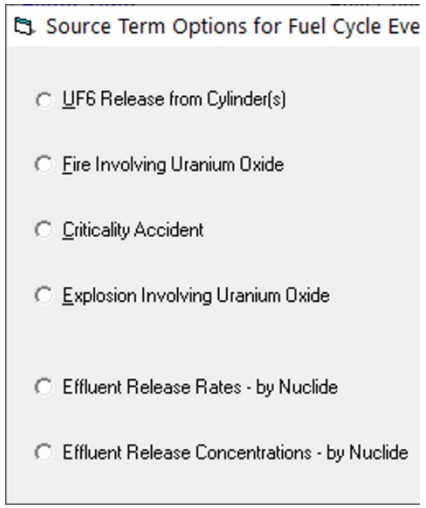
## Nuclear Power Plant



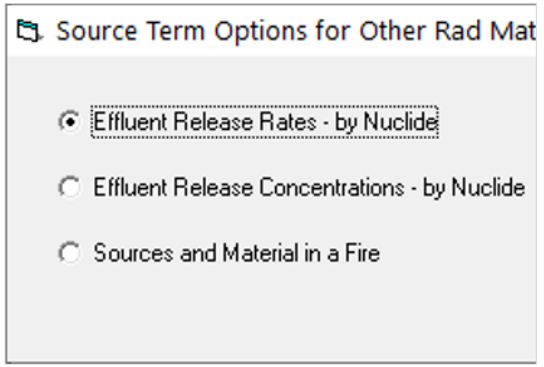

## Spent Fuel



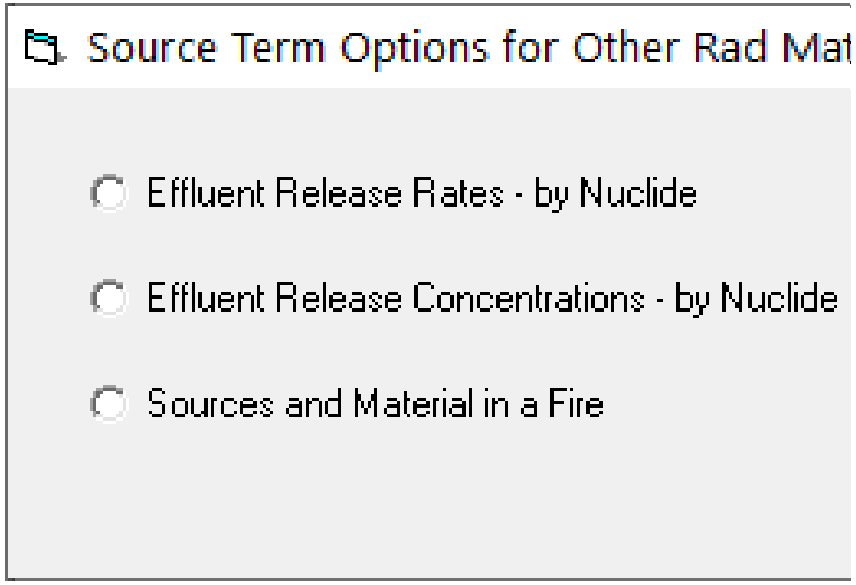

## Fuel Cycle




## Other Materials



# Other Materials Locations

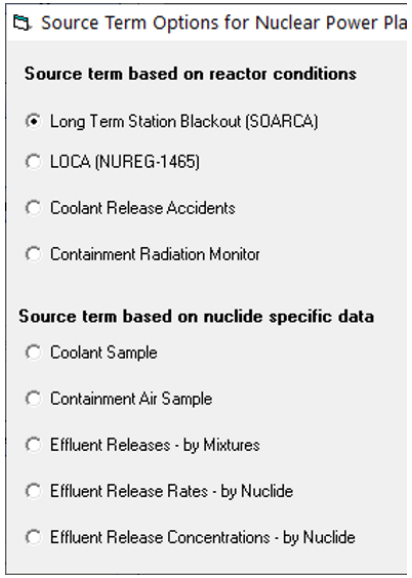




- RASCAL also has 3 “other” materials options
- Useful for modeling transportation accidents, lab accidents, etc.
- All models still focus on atmospheric releases
  - Liquid releases (like spills and leaks) are not modeled in RASCAL

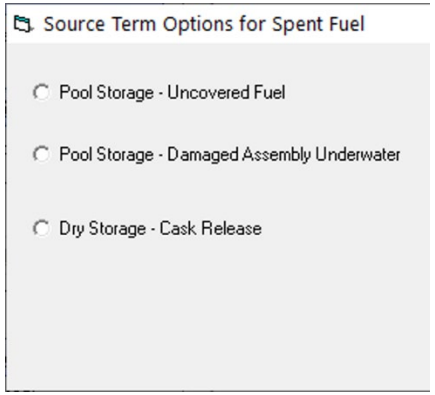
# Source Term

- Source term models calculate material that can be released
- Pick the best model; may have multiple options
- Available choices depend on Event Type

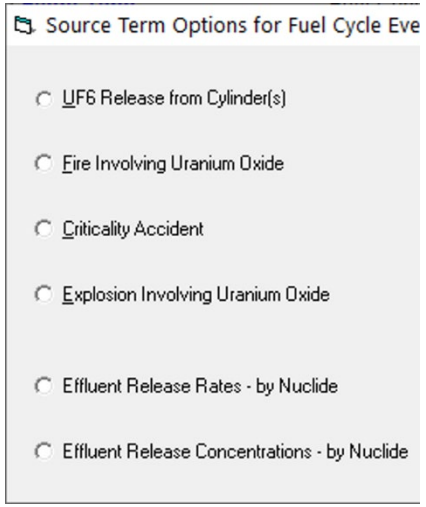
## Nuclear Power Plant



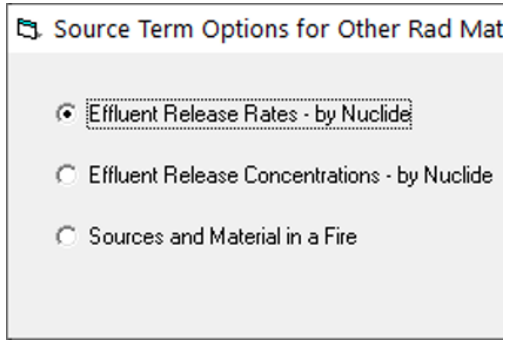

## Spent Fuel



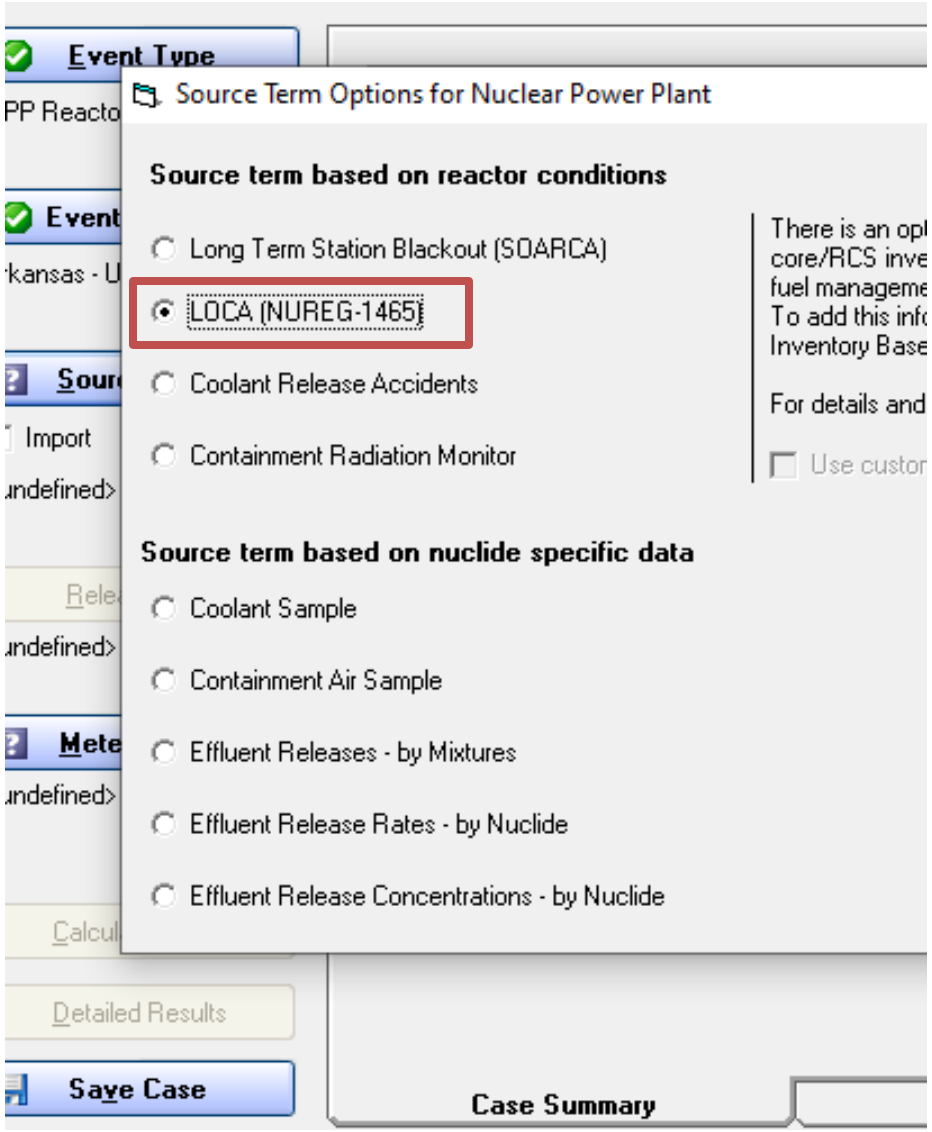

## Fuel Cycle




## Other Materials

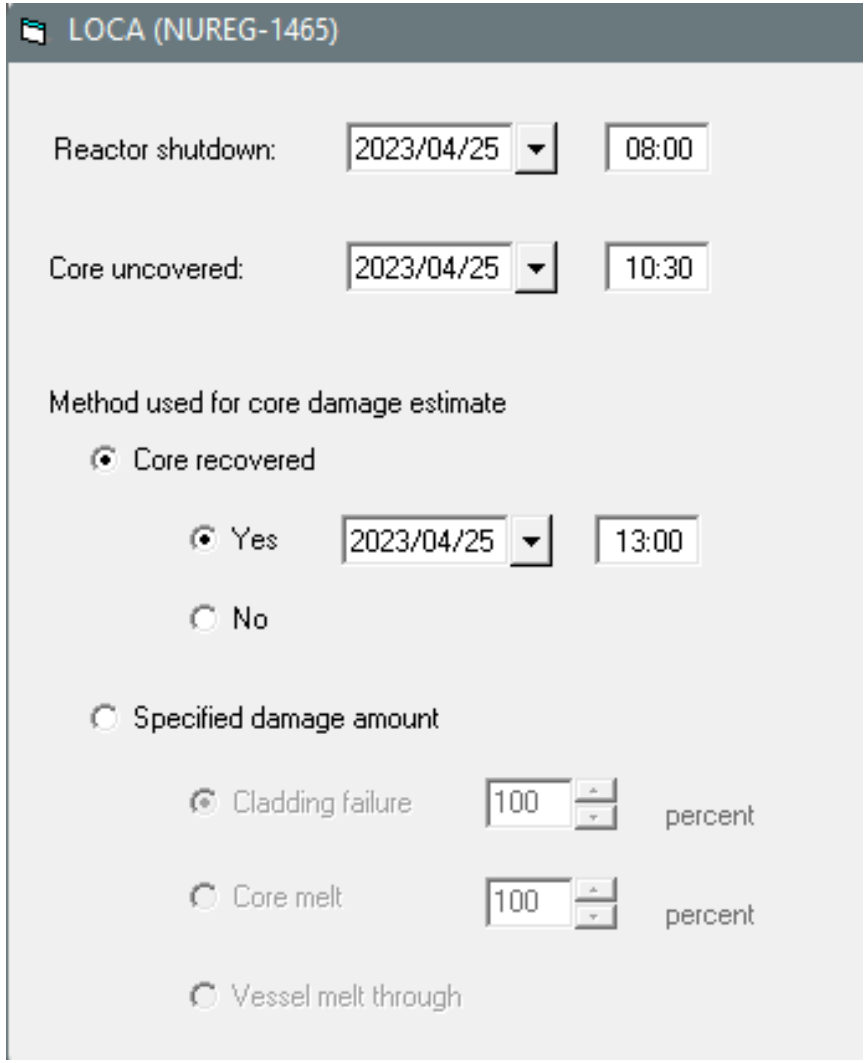


# Pick a Source Term




For this scenario, the most appropriate model would be the LOCA model

# Enter Source Term Details




- Each model requires additional details like timing or measurements
- For the LOCA model:
  - Time of reactor shutdown
    - Starts the decay of all nuclides in the core (they're in equilibrium before)
  - Time core was uncovered
    - When NUREG-1465 models start, starting with 30 min of gap activity, then fuel melt
  - Is the core recovered?
    - Additional material stops being generated after the core becomes recovered
- All times entered with 24-hour clock

# Your Turn to Use RASCAL


- Click Source Term
- Select Loss of Coolant Accident (LOCA)
  - Click OK
- Input timing sequence numbers
  - Shutdown Time - 0800
  - Time of Core Uncovery – 1030
  - Select Yes for Core Recovered, Time – 1300
  - Click OK

*Reminder to use today's date; not screenshot dates

# LET'S WALK THROUGH TOGETHER

# Knowledge Check

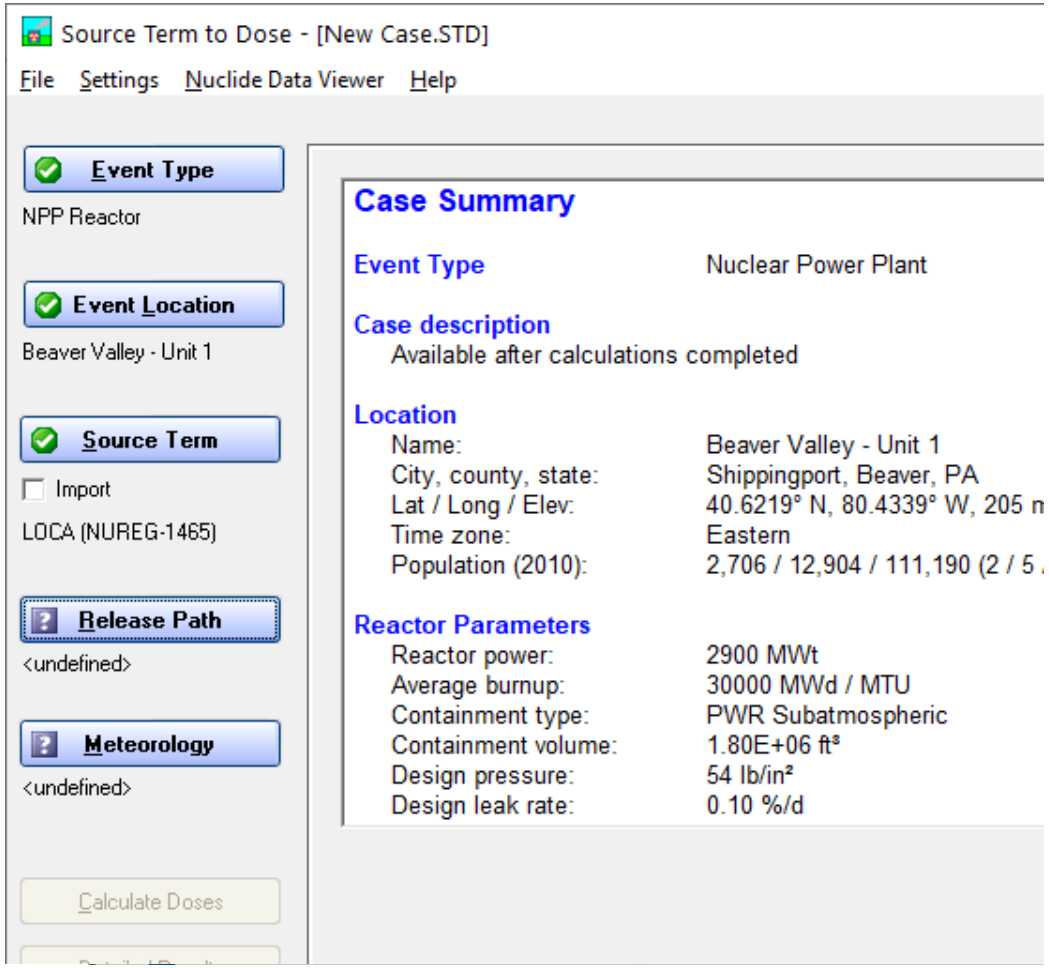
Why is it important to enter the reactor shutdown time?

- That is when the radionuclide decay calculation starts
- That is when the release starts
- That is when the damage to the reactor fuel begins

If the core is recovered, will there still be a release to the atmosphere?

- Maybe, it depends on the release pathway and leak rate
- Yes, that just stops further damage to the core
- No

# As you can see, the Case Summary tab updates as information is added




As each step is completed, the input information is added to the case summary displayed.

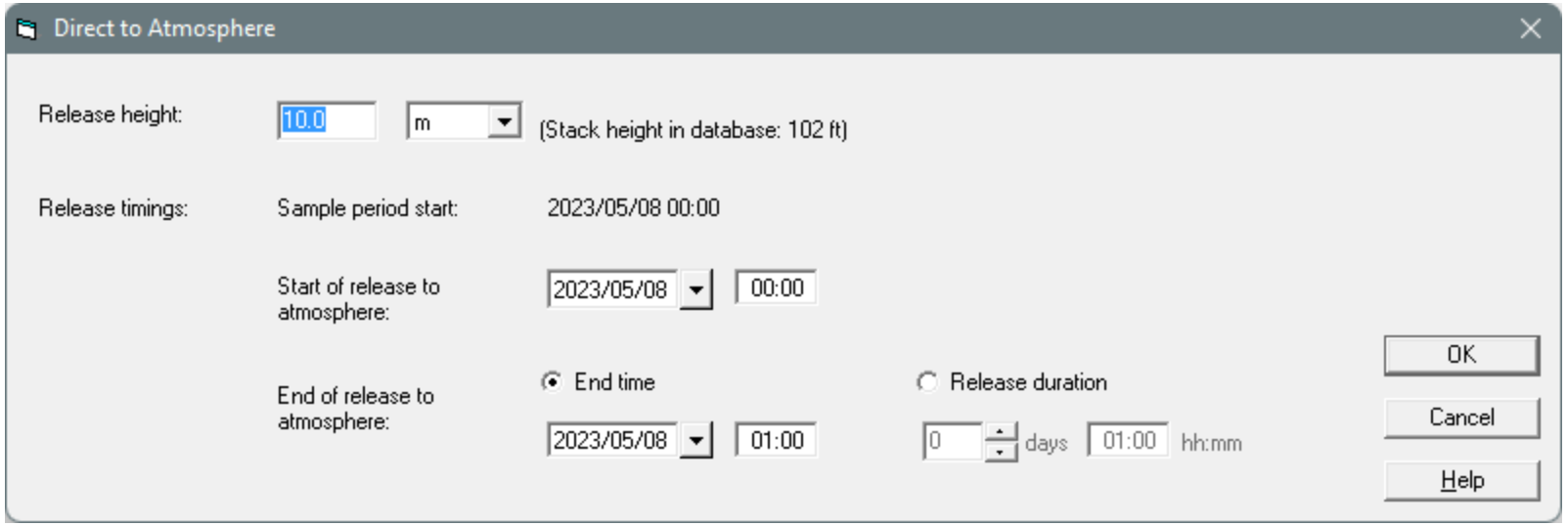
# Now We'll look at Release Pathway

- Pathway information is combined by the model with the source term details entered earlier to generate the atmospheric source term
- RASCAL will only show pathways applicable to the defined source term type
- For example
  - Effluent release rates source terms are direct to atmosphere – no options to choose from
  - LOCA source terms can release through containment leakage, steam generator, or containment bypass

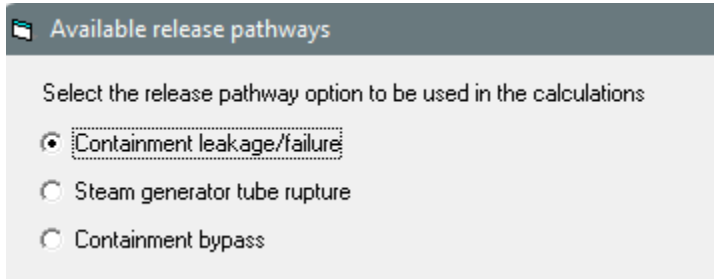
# PATHWAY DEFINITIONS VARY IN COMPLEXITY - SIMPLE

**The Direct to Atmosphere is simple:**

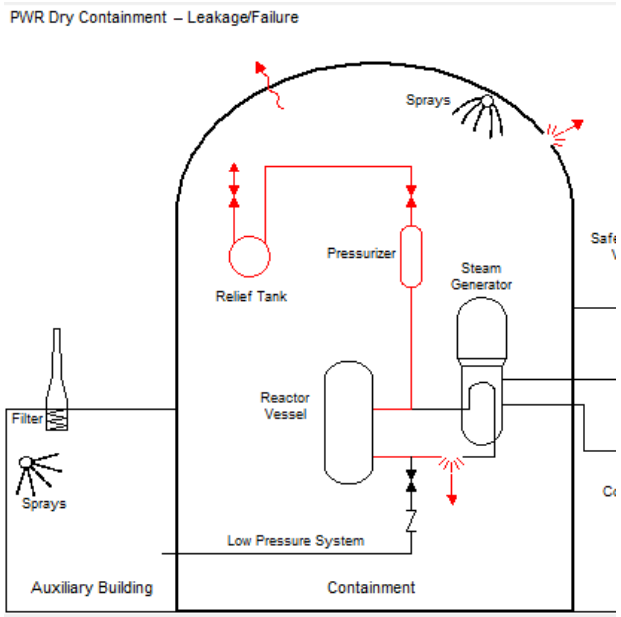
- **Release height**
- **Start of release**
- **End of release or release duration**

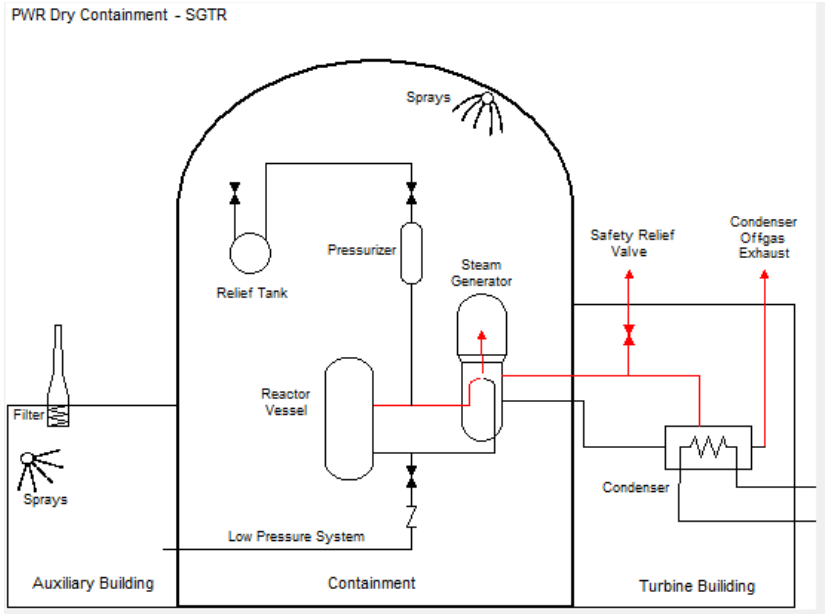


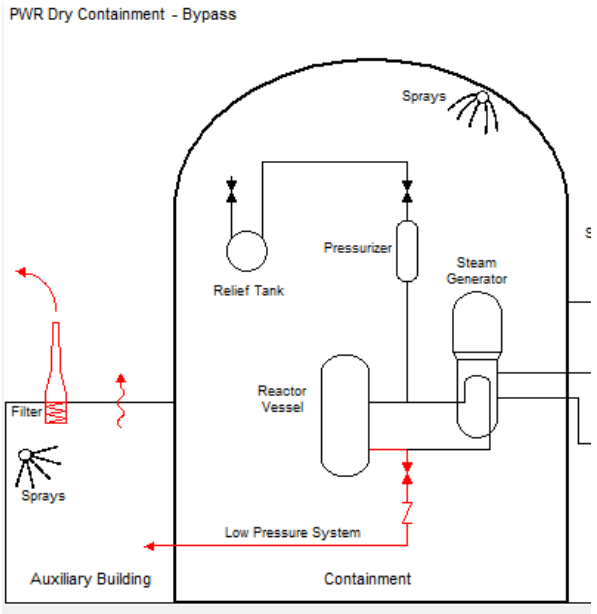
# PATHWAY DEFINITIONS VARY IN COMPLEXITY - COMPLEX



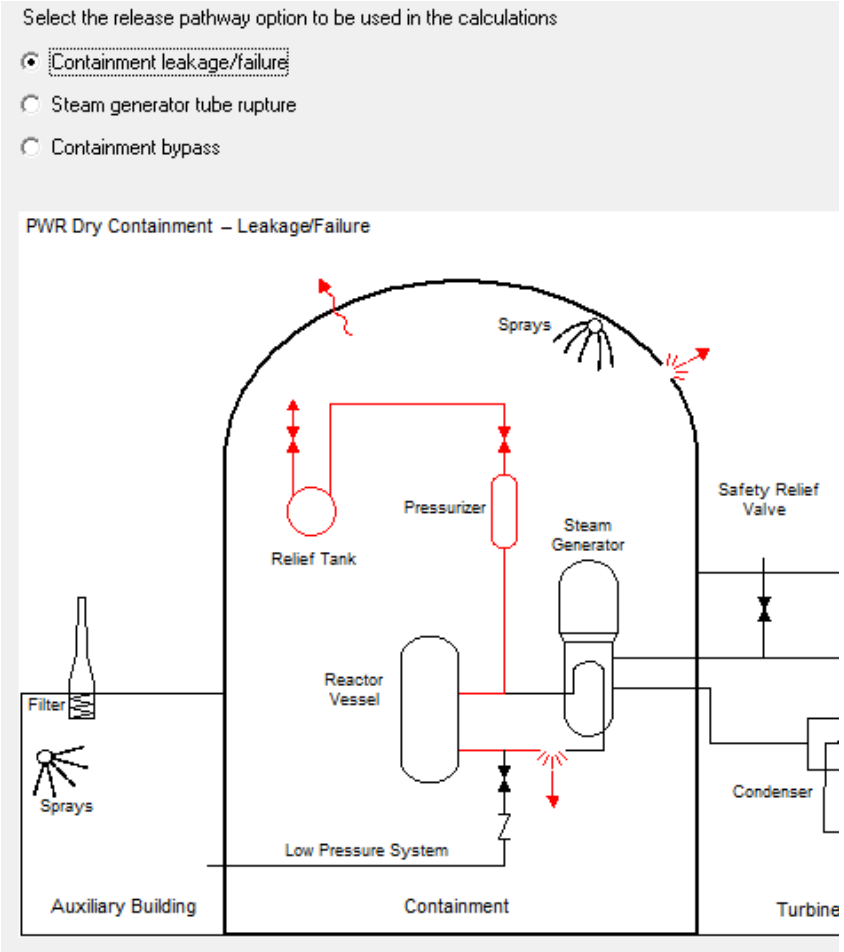

Will need information on to describe leak rates and reduction processes



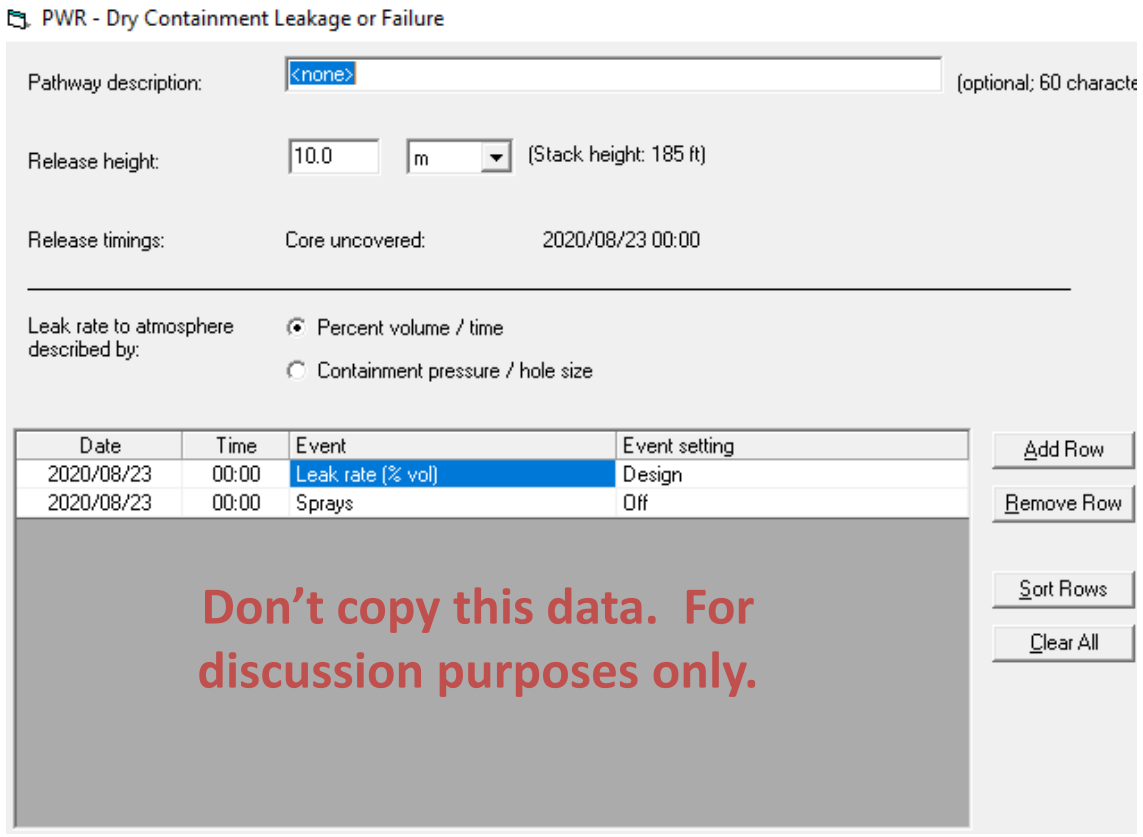



# PICK A RELEASE PATHWAY TO BE USED




For this scenario, the most appropriate option is *Containment leakage / failure*

# For this Release Pathway option, We'll need to input:




- Release Height
  - 10m is minimum height allowed (ground release)
- Select leak rate type
  - Percent Volume / Time (e.g., 3%/hour)
  - Containment pressure / Hole Size (e.g., 30 psi/2 $cm^2$)
- Define release timeline
  - Used for leak rate and additional conditions
  - Need to review/set initial conditions, then can add rows as needed

# Your Turn to Use RASCAL


- Click Release Path
- Select Containment leakage/failure, Click OK
- Ensure release height is set to 10m
- Change the initial leak rate (at 10:30) to 5% / day
- Keep sprays off
- Add row and enter
  - Time: 18:00  Event Type = Leak rate  Setting = 0.0 %/d
- Click OK

*Reminder to use today's date; not screenshot dates

# LET'S WALK THROUGH TOGETHER

# Knowledge Check

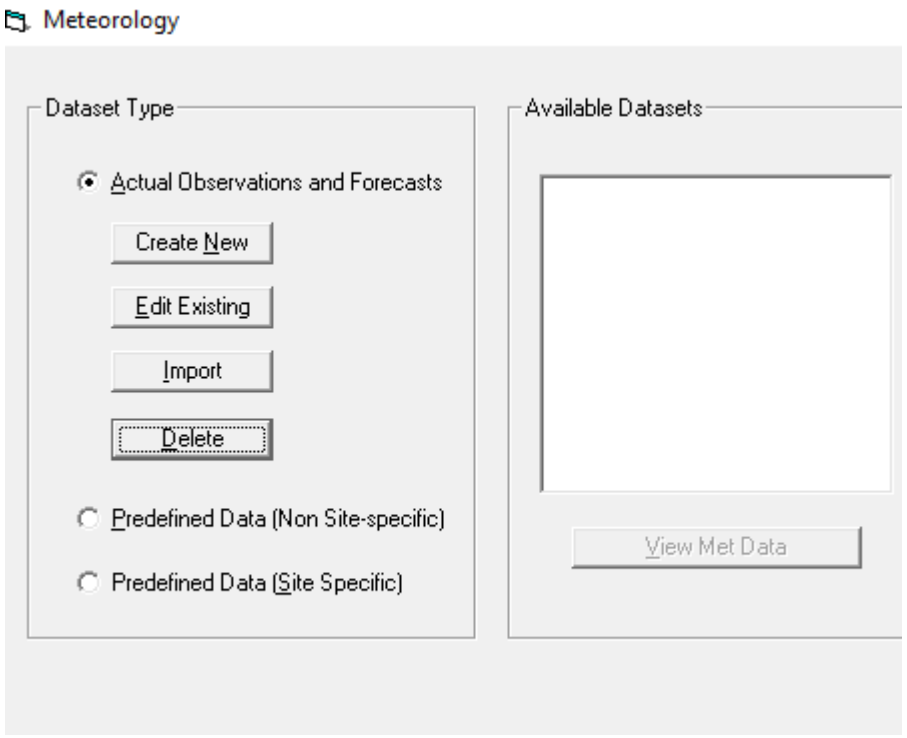
For a LOCA accident, RASCAL can model the release of material to the atmosphere through which of the following pathways? [select all that apply]

- Containment
- Steam generator
- Bypass of containment via other systems
- Direct from the reactor vessel

T or F, in RASCAL a release height of 10m is considered ground level?

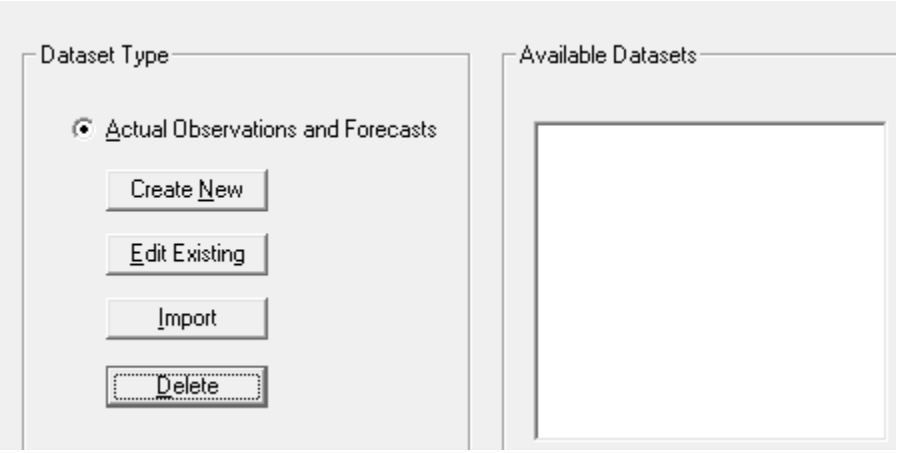
- True
- False

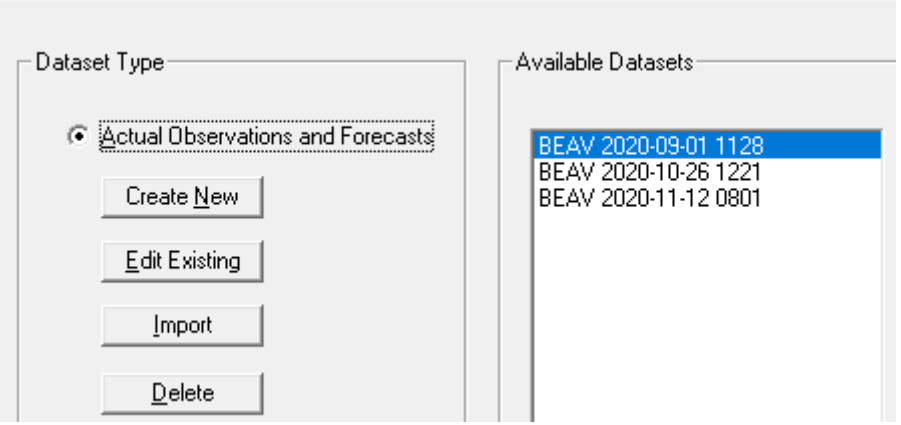
# Moving onto Meteorology




- Actual
  - Enter station observations/forecasts
  - Manual entry or internet download
- Pre-defined (non site-specific)
  - Simple static weather conditions
  - Easy/fast if no meteorological data known, but doesn't include topo/roughness
- Predefined (site-specific)
  - Allows custom creation of likely conditions

# We'll Mostly Use Actual for Exercises/Events



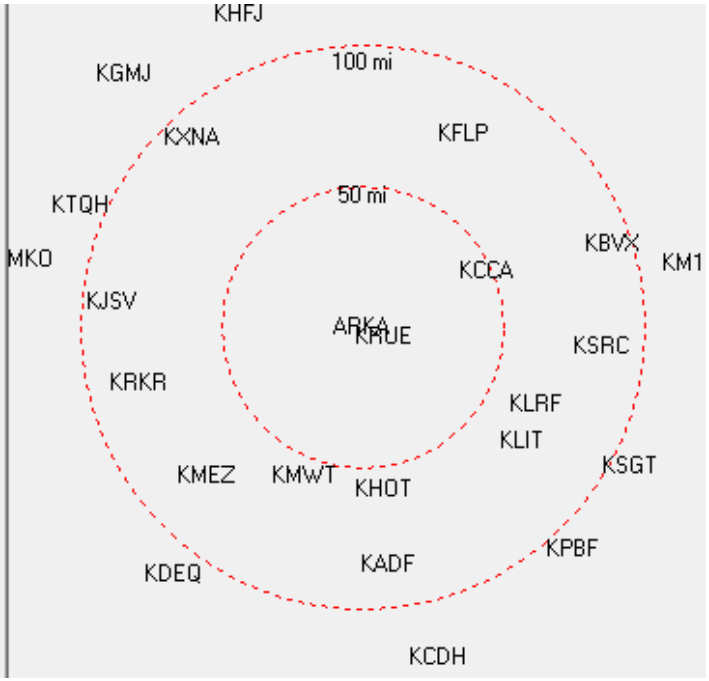




- We won't use pre-defined except in training
- For actual conditions, weather data is managed as site-dependent files
  - Create New / Edit
  - View any previously saved weather files
  - Usable as long as times support scenario

# EACH SITE CONTAINS PREDEFINED WEATHER STATIONS

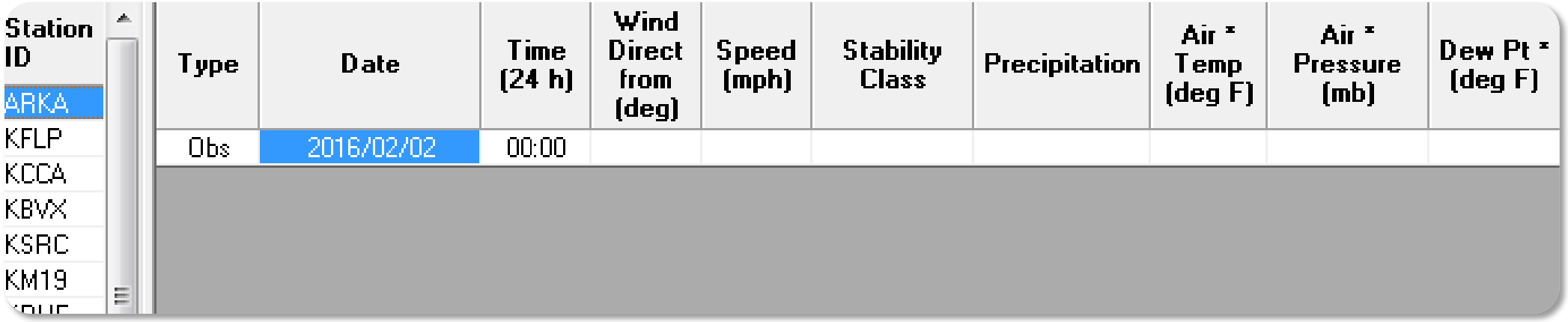
Available meteorological stations

| Station ID | Distance (miles) | Bearing (deg) |
|---|---|---|
| ARKA | 0.0 | 0. |
| KFLP | 77.3 | 27.8 |
| KCCA | 48.1 | 65.6 |
| KBVX | 93.4 | 71.7 |
| KSRC | 84.6 | 94.6 |
| KM19 | 117.6 | 78.9 |
| KRUE | 8.6 | 114.4 |
| KLRF | 67.0 | 113.9 |
| KSGT | 106.6 | 117.4 |
| KLIT | 69.4 | 125.5 |
| KPBF | 107.9 | 136.6 |
| KCDH | 120.0 | 167.1 |
| KHOT | 58.0 | 172.4 |



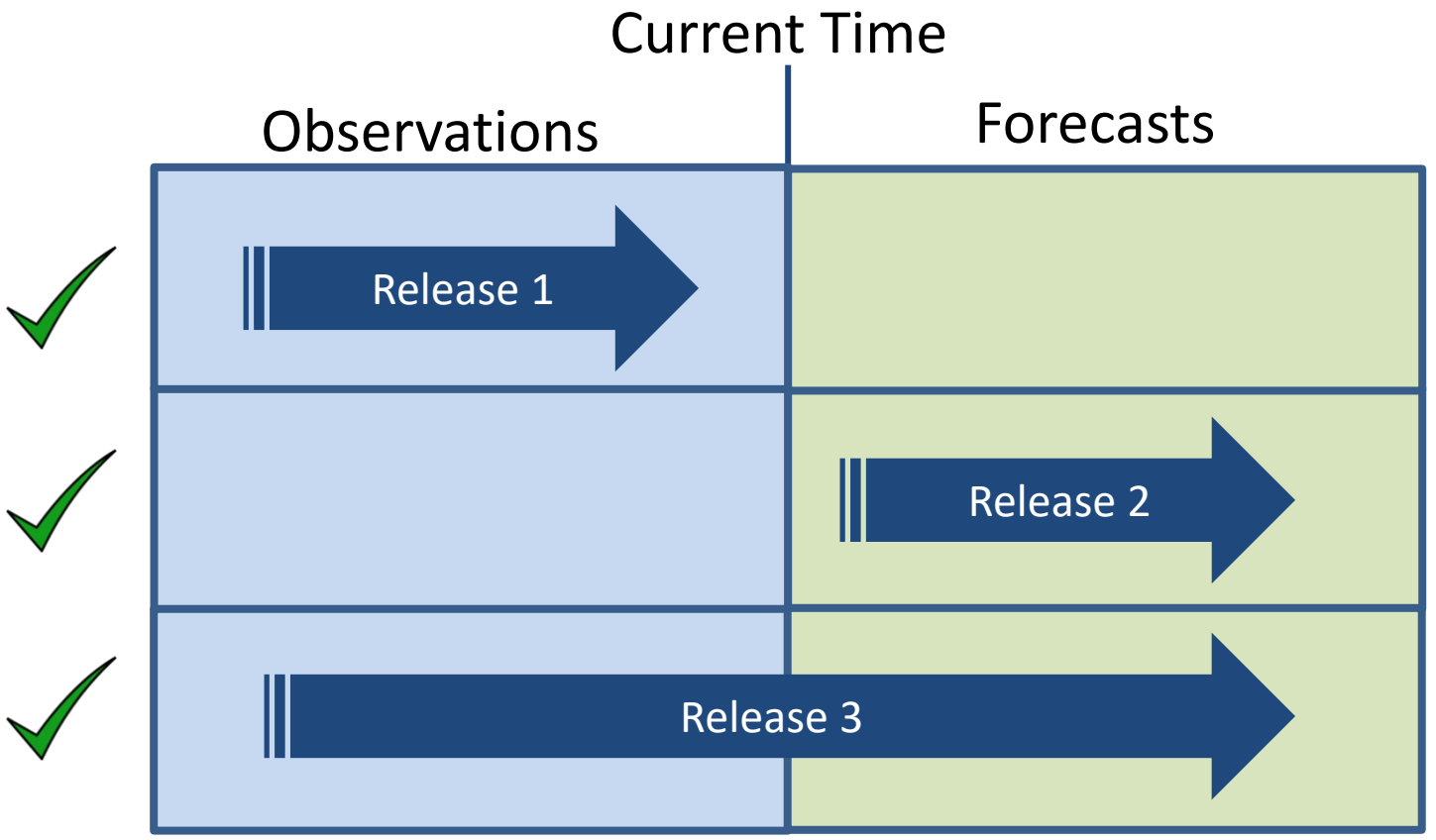

- Table and map show site and surrounding weather stations
- Select stations with plume direction in mind

# Inputting Weather Data



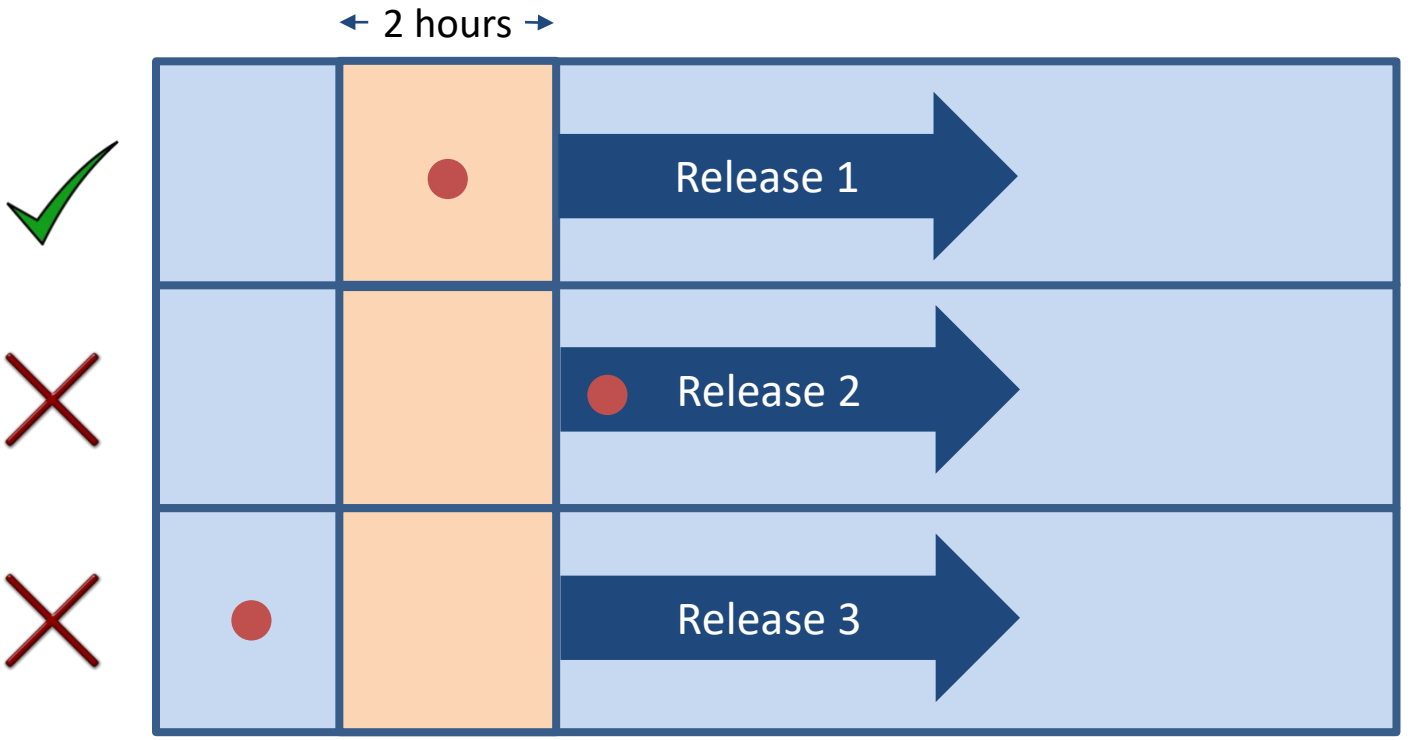

- Select weather station on the left to input its data on the right:
  - Type
  - Date/Time
  - Wind Direction/Speed
  - Stability
  - Precipitation

# RASCAL USES OBSERVED AND/OR FORECAST WEATHER DATA



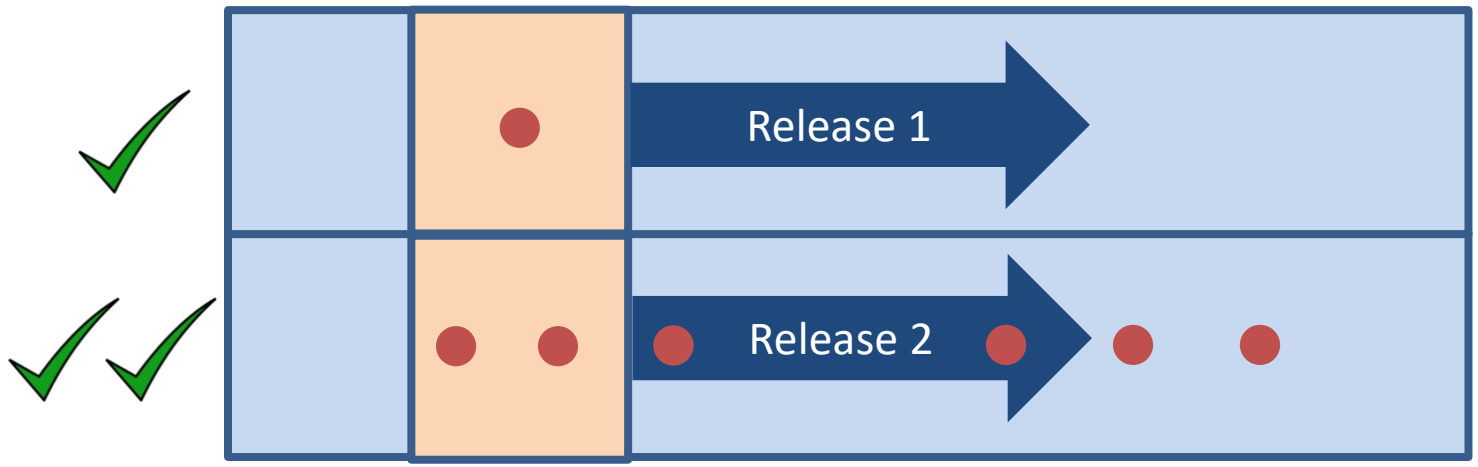

RASCAL can model releases in the past (all observations), in the future (all forecasts), or that span both.

# RASCAL Can Run with a Single Weather Datapoint




However, the initial meteorological data must fall within 2 hours before the start of the release to the atmosphere. (Release starts at 10:30;  must have some meteorology defined within the 8:30 to 10:30 window)

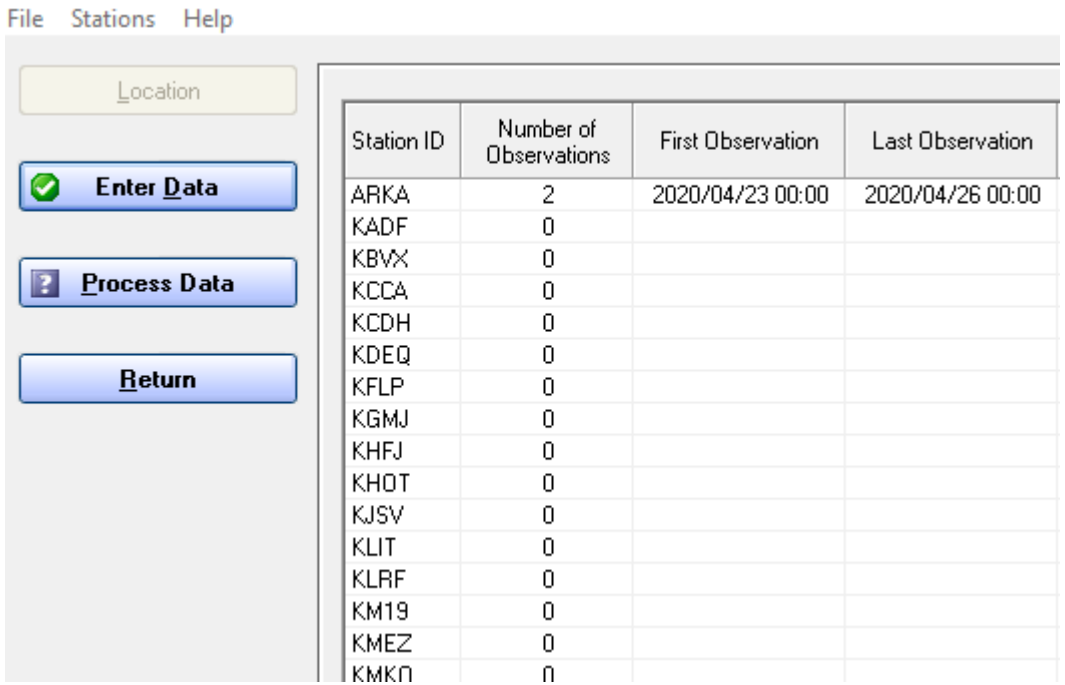
# Although Single Datapoint Weather is possible, More Data is Preferred




Important when the release may start in the future or may continue for some period of time. You will likely need both observed and forecast data.

However, our scenario doesn't have additional info like forecasts yet.

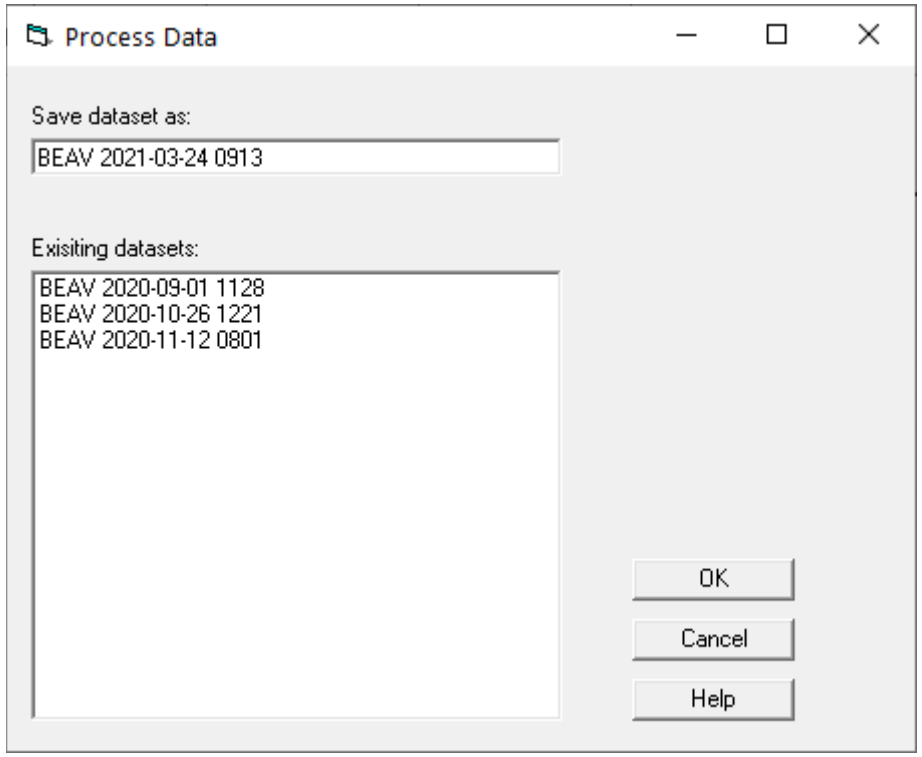
# PROCESS DATA



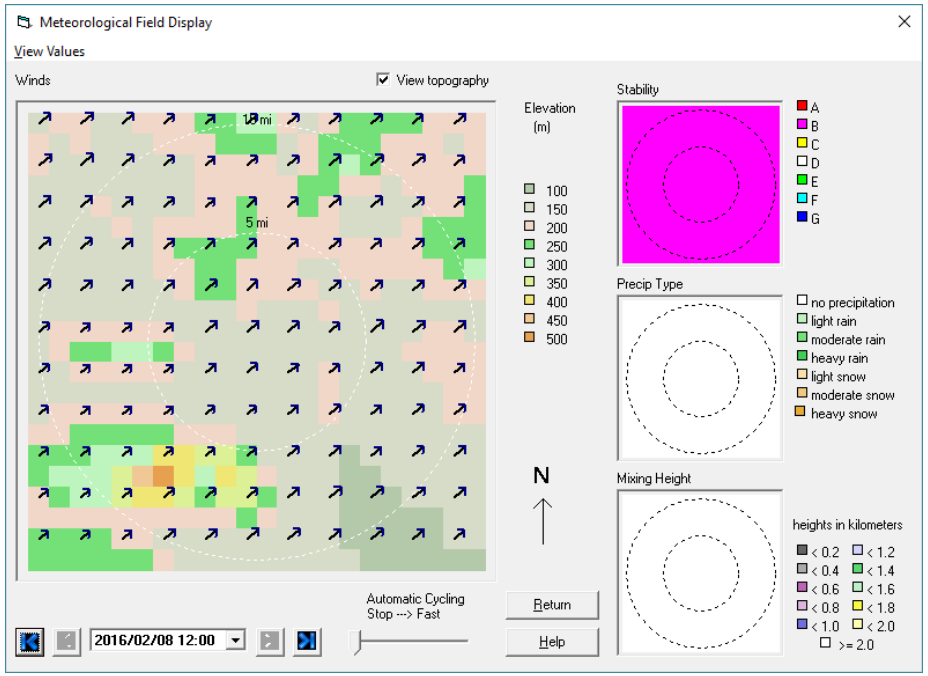

Click Process Data to compile all the weather data into a form that the models can use.

# RASCAL PROCESSES ALL ENTERED DATA INTO A MERGED GRIDDED FIELD THAT CHANGES OVER TIME

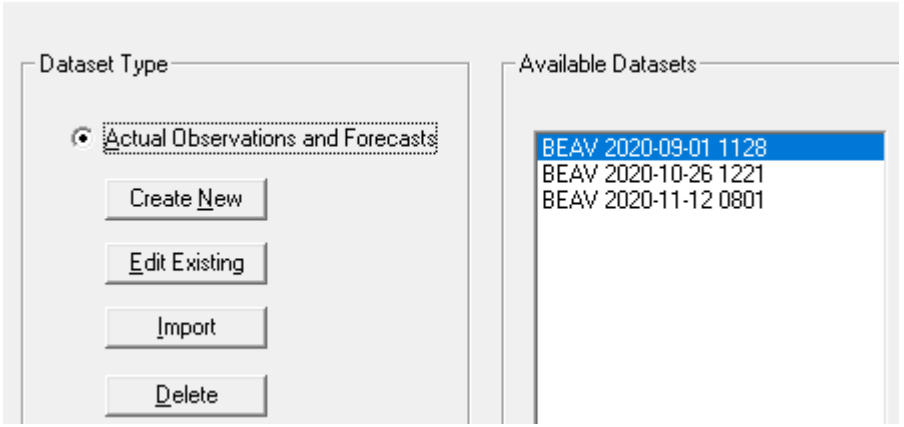
- This named file will show on the main met screen




- Weather details can be viewed if needed (View dataset)



# Finally, Select Which Weather File You Want RASCAL to Use




- RASCAL will return to the main Meteorology screen
- Highlight the desired weather data
  - Likely the one at the top

# Your Turn to Use RASCAL


- Click Meteorology
- Select option for Actual Observations and Forecasts
  - Click Create New button
- Click Enter Data button
- For the BEAV station enter the following:
  - Date: Today  Time = 10:00
  - Winds = from 45 deg at 2 mph
  - Stability class = B
  - Precipitation = None
  - Click OK
- Click Process Data button then click OK
- Click the Return button
- Make sure your newly created file is selected in blue in the list of available datasets. Click OK

# LET'S WALK THROUGH TOGETHER

# Knowledge Check

T or F, pre-defined weather conditions are acceptable to use in a real event?

- True
- False

T or F, RASCAL requires at least some weather data to drive the ATD models?

- True
- False

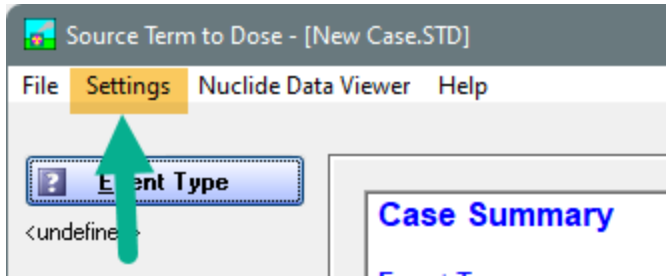
T or F, RASCAL allows you to enter weather data that varies in both space and time?

- True
- False

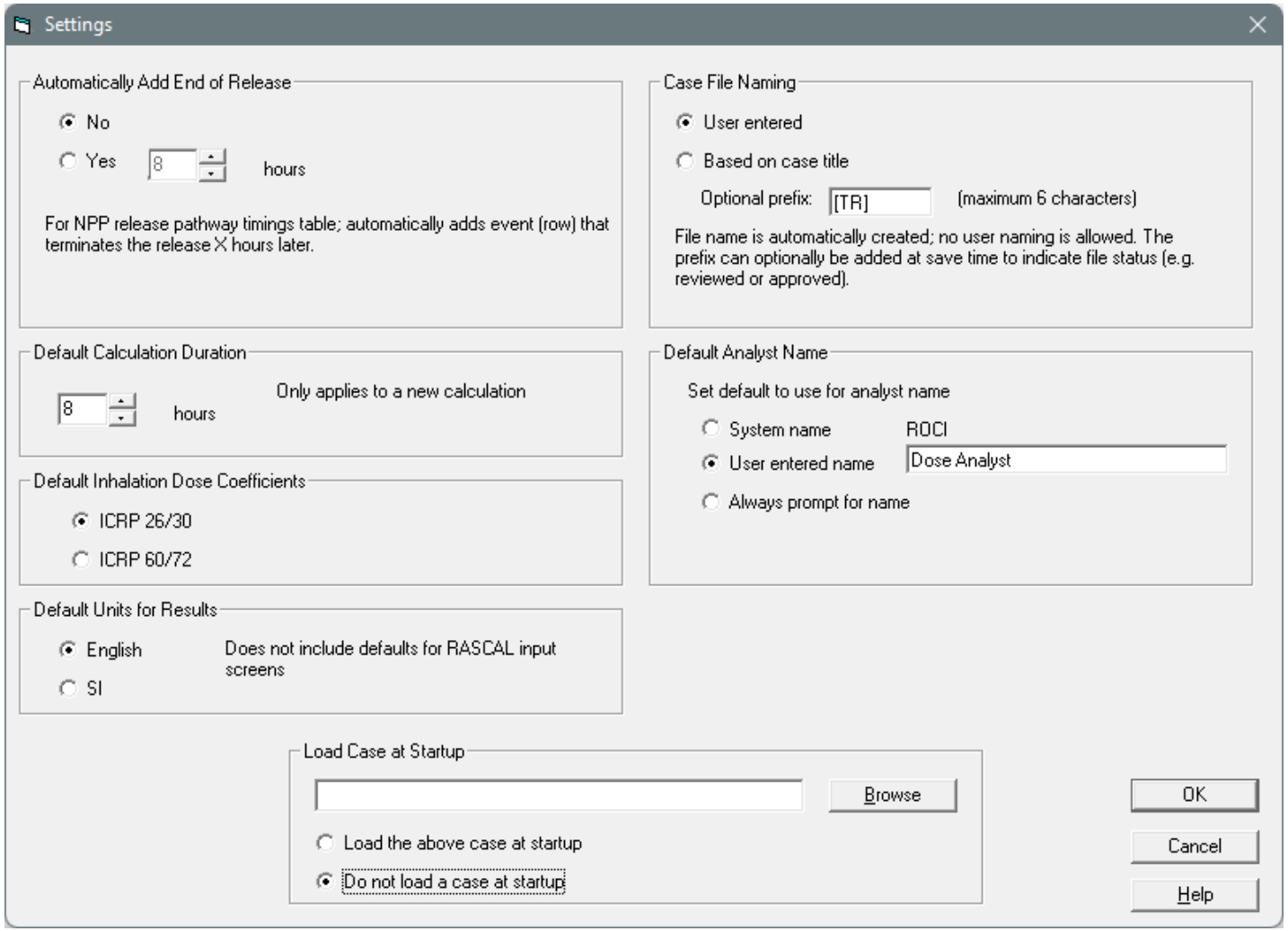
T or F, RASCAL can model a release that may occur in the future?

- True
- False

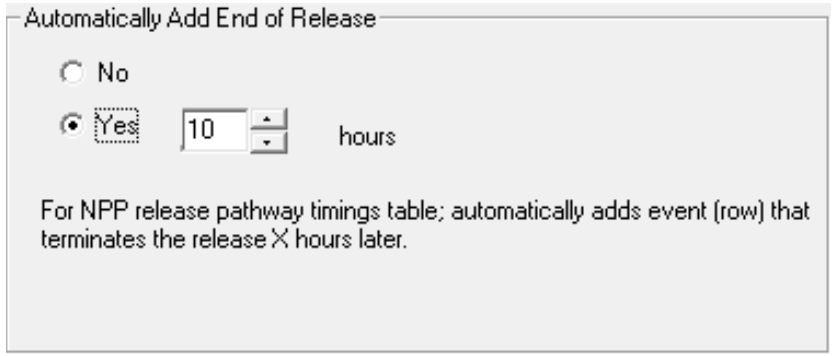
# STDOSE SETTINGS




The Settings button on the main menu provides access to a variety of options that control how STDose operates.



# SETTINGS – AUTOMATICALLY ADD END OF RELEASE

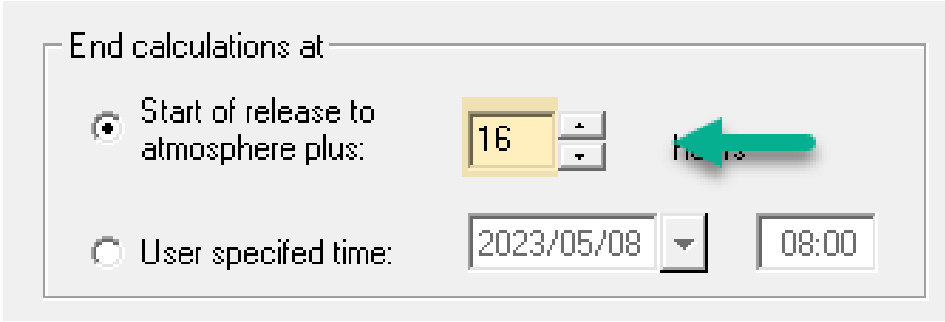



See below that a row was added to the usual default conditions to set the release rate to zero. That event was given a time 10 hours after the start of the release.

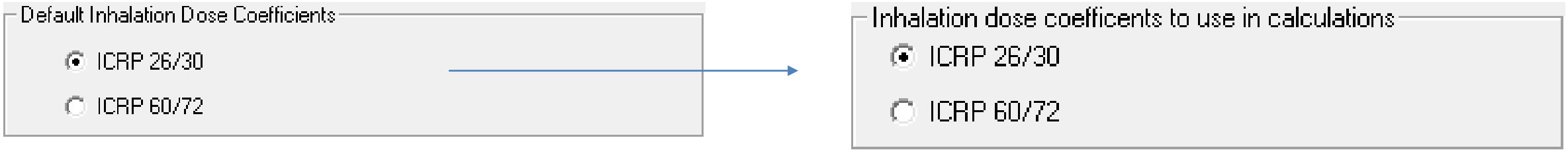
| Date | Time | Event | Event setting |
|---|---|---|---|
| 2023/05/08 | 02:00 | Leak rate (% vol) | Design |
| 2023/05/08 | 02:00 | Sprays | Off |
| 2023/05/08 | 12:00 | Leak rate (% vol) | 0. %/h |

# SETTINGS – DEFAULT CALCULATION DURATION


See to the right that the default end of calculations was set to the selected 16 hours after the start of release to atmosphere. It can be changed at this point but the initial value is from the settings.

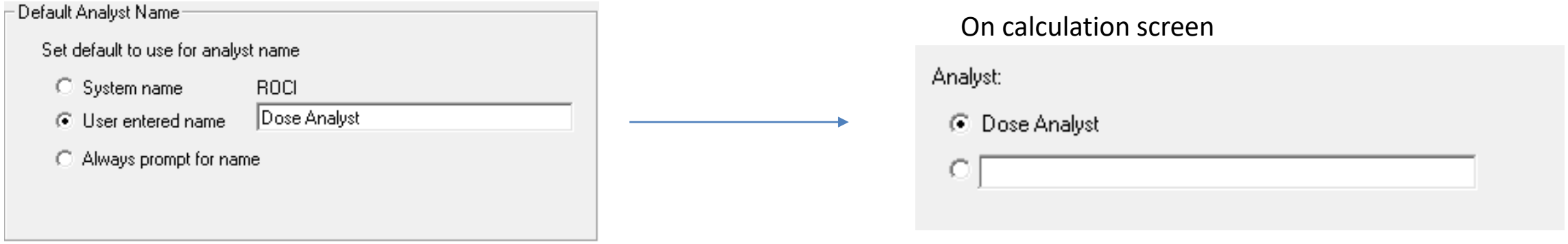


# SETTINGS – DEFAULT INHALATION DOSE COEFFICIENTS



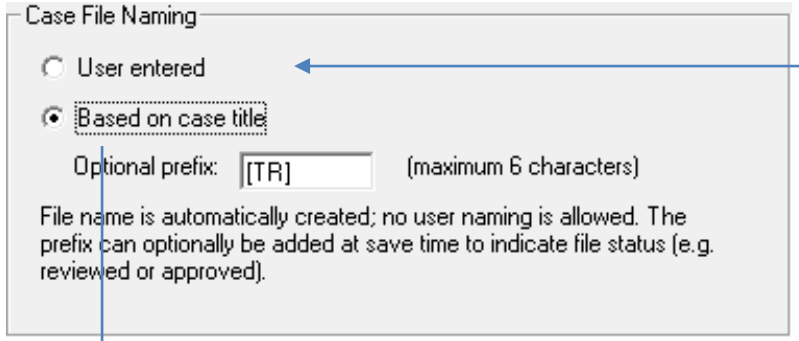

- This is only the default and can be changed at calculation time
- Most of U.S. still uses IRCP 26/30, but the new EPA Protective Action Guidelines are published for interim use and incorporate IRCP 60/72

# SETTINGS – DEFAULT ANALYST NAME




- This is only the default and can be changed at calculation time with the 2nd option.
- Can enter any text but suggest name and maybe some contact information such as phone number or email address.
- This kind of labeling can be very important in long events where multiple people are running the model and generating products.

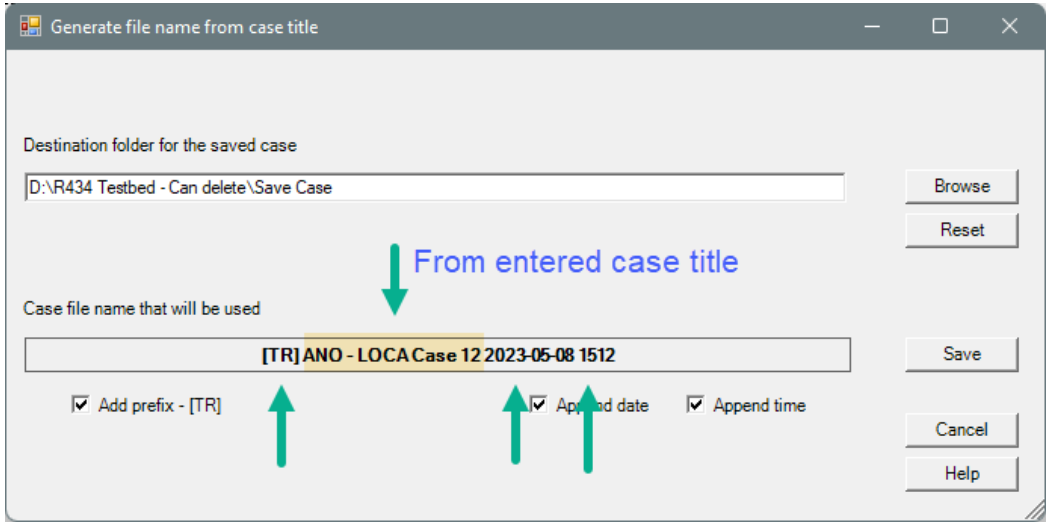
# SETTINGS – CASE FILE NAMING



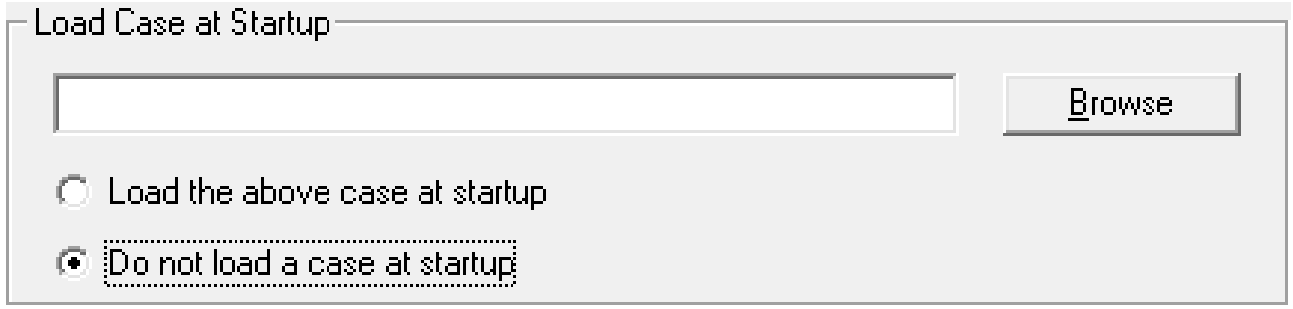

*User entered* is the standard Windows method of specifying folder and filename

*Based on case title* allows selection of folder but file name is generated from the title entered on the calculation screen.

The file name can be modified with some fixed additions.



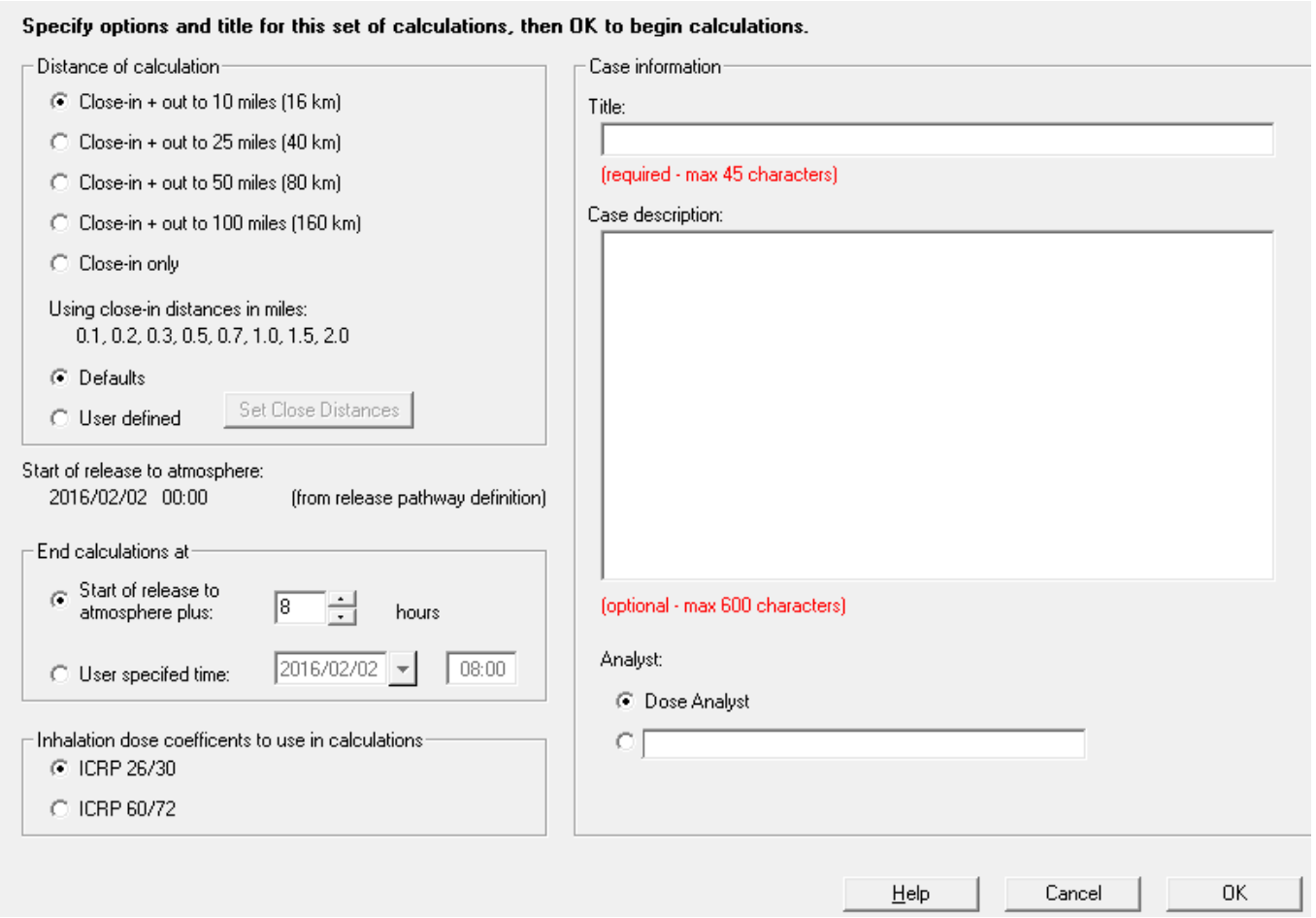
# SETTINGS – LOAD CASE AT STARTUP




You can browse to select a saved RASCAL STDose case. Enabling the load option will have that case opened when the program starts.

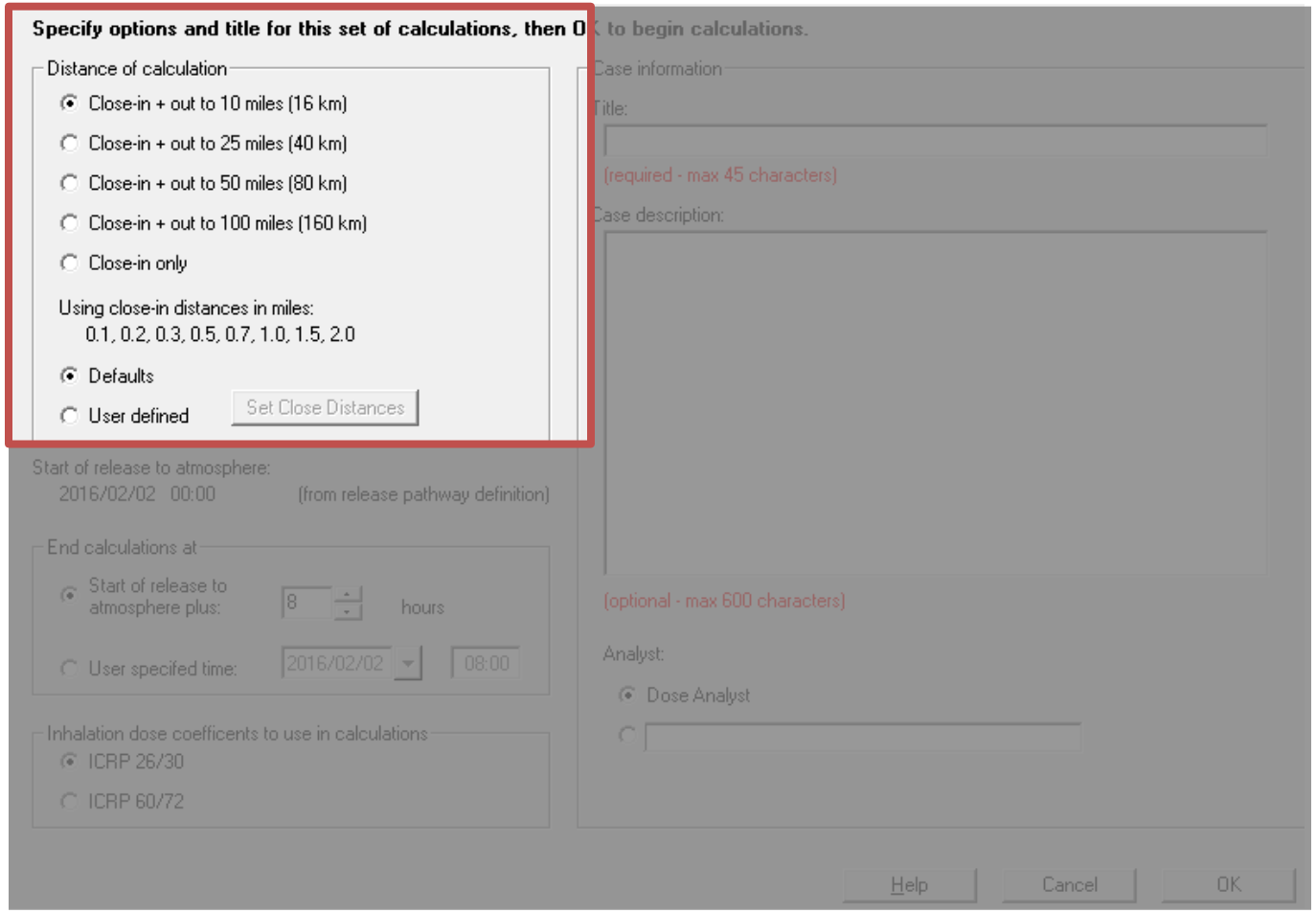
This is a rarely used option since it easy enough to start the program and open a case. It *might* be useful if the same case was *always* to be used.

# CALCULATE DOSES



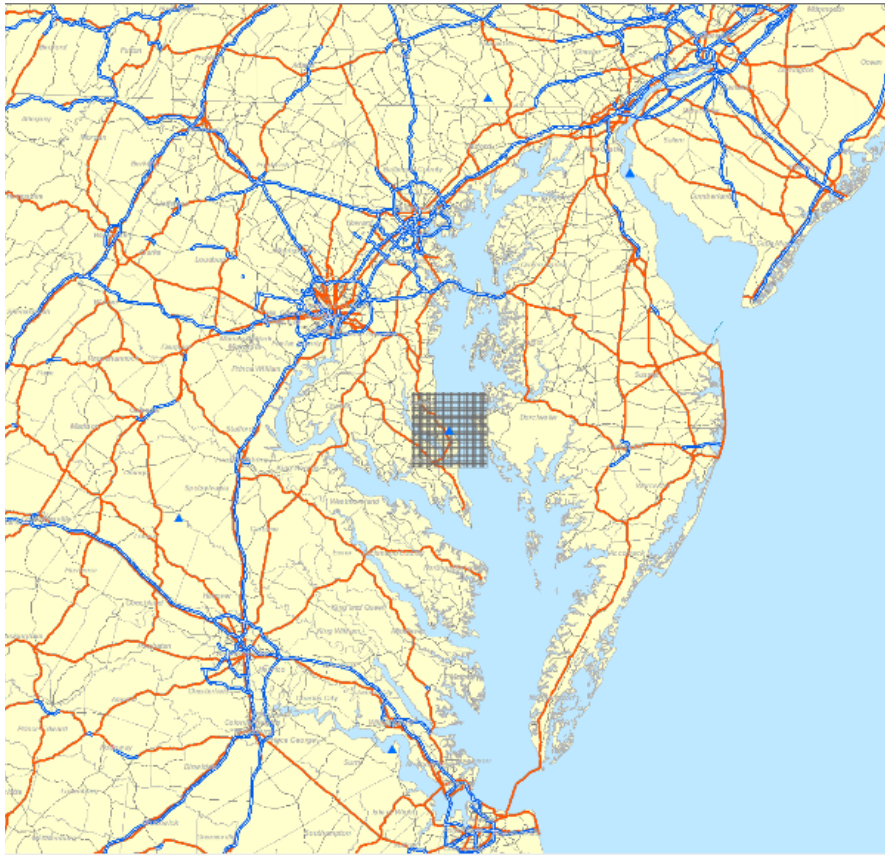

- Nothing has been calculated at this point
- With a few additional parameters, RASCAL will perform all its calculations

# PICK A DISTANCE TO SET THE CALCULATION AREA

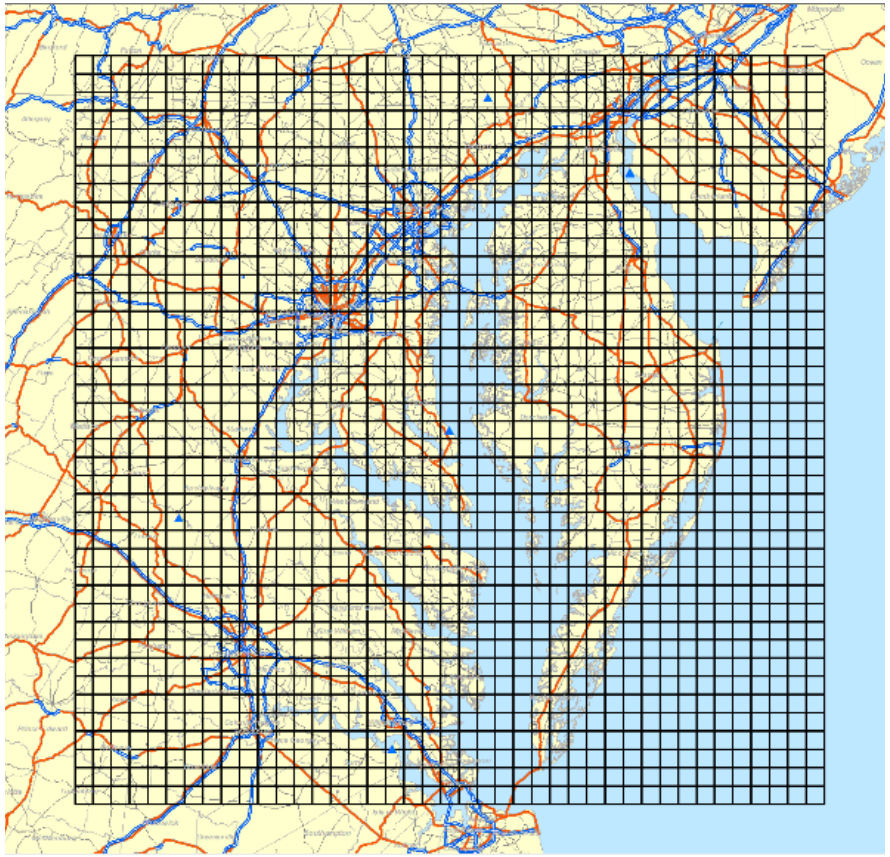



- Shorter distances provide higher resolution
- Rule of Thumb – start on the 10 mile distance. If doses are high at the 10 mile edge, go to 25 miles

# CLOSER CALC DISTANCES PROVIDE BETTER RESOLUTION IF YOU DON'T NEED TO SEE FURTHER OUT

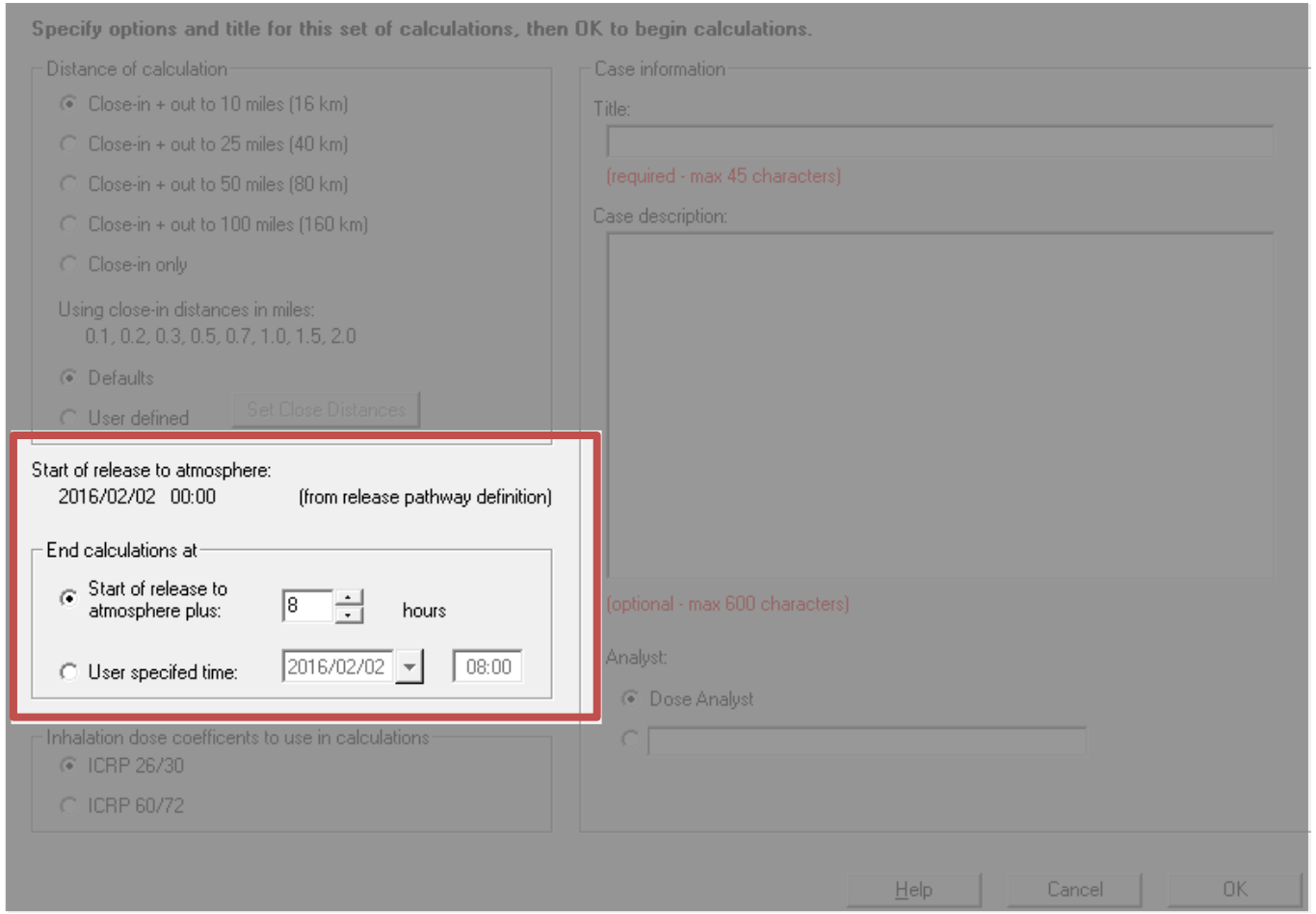


10 mile grid – cells are .5 mile wide



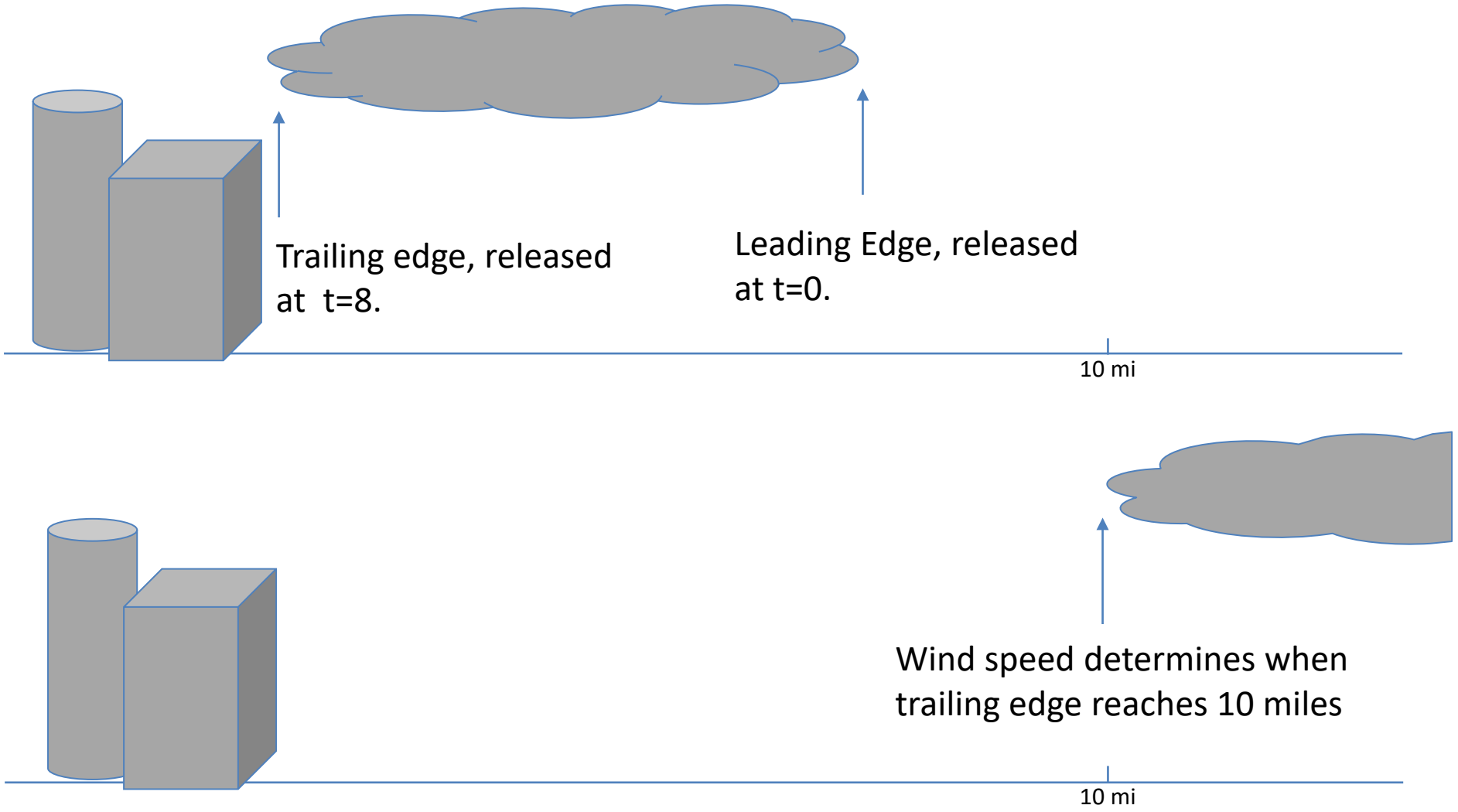
100 mile grid – cells are 5 miles wide

# Define a Calculation Time



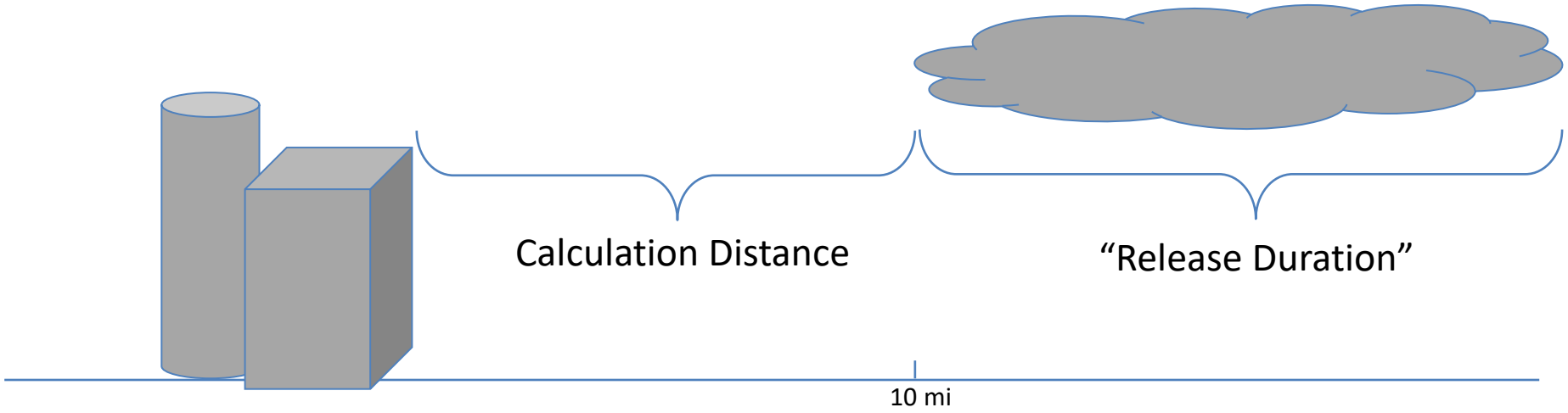

- Duration after the first release to atmosphere that RASCAL terminates the release, plume movement and dose calculations
- If time is set too short, dose may be missed; no disadvantage to going long (except runtime)

# SET CALCULATION DURATION TO ALLOW FOR TRAILING PLUME EDGE TO REACH SET DISTANCE



# THERE IS A RULE-OF-THUMB FOR ESTIMATING THE CALCULATION DURATION

$$Calculation\ Duration \geq \left(Release\ Duration + \frac{Calculation\ Distance}{Wind\ Speed}\right) \times 1.1$$

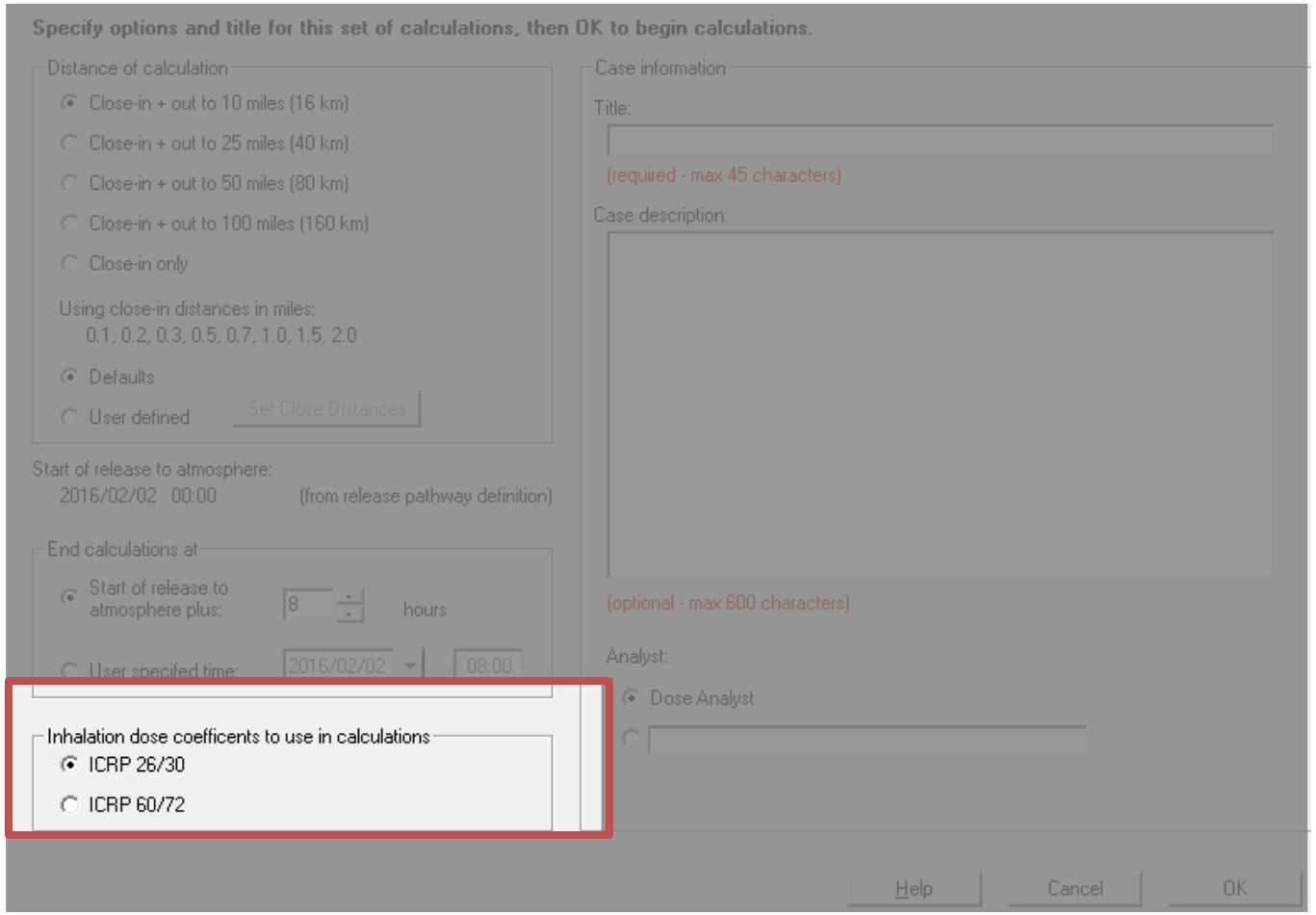



For our problem, 7.5 hr release with 2 mph winds, calculate a duration for a 10-mile grid.

7.5 hours + (10 miles / 2 mph) = 12.5 hours

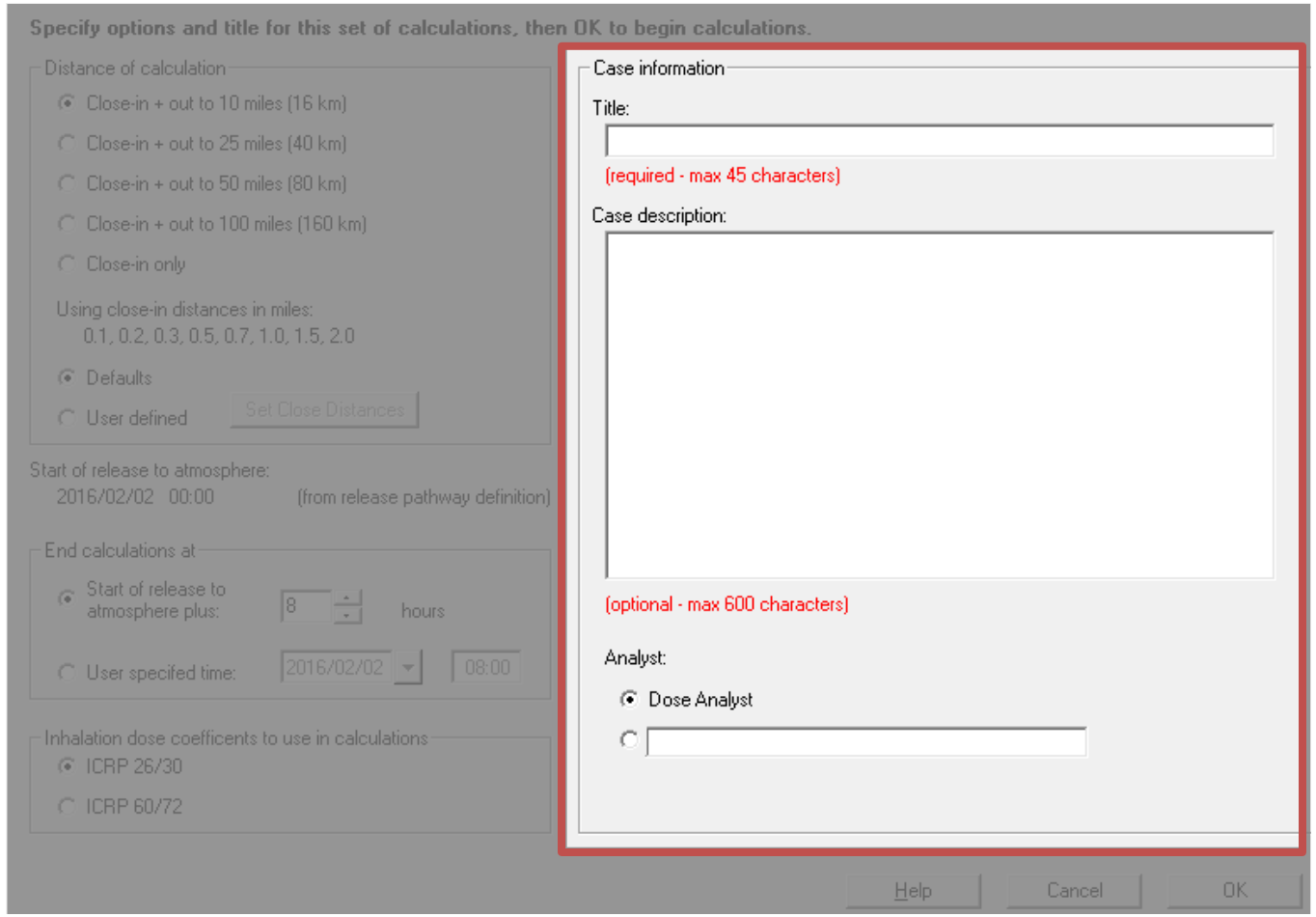
Add 10% to get 13.75, then round up to the nearest hour (14)

# SELECT THE INHALATION DOSE COEFFICIENTS TO BE USED




- ICRP 26/30 vs 60/72
- Currently, NRC and most States use 26/30
- New EPA PAG Manual uses 60/72
- Differences are inclusion of child thyroid CEDE and some minor dose values changes

# ENTER THE CASE INFORMATION




- RASCAL requires a case title
- Description used for justification or special notes; don’t need to repeat case info
- Select and/or define an analyst name

# What happens when the OK button is clicked?

- RASCAL calculates the atmospheric source term and runs the ATD models with the given weather
  - You cannot interrupt the calculations
- Once complete, view results tabs at the bottom
  - Case Summary
  - Source Term
  - Maximum Dose Values

# Your Turn to Use RASCAL


- **Click Calculate Doses**

- **Leave Distance of Calculation at 10 miles**
- **Set End Calculations at:**
  - **Start of release to atmosphere plus: 14h**

$$Calculation\ Duration \geq \left(Release\ Duration + \frac{Calculation\ Distance}{Wind\ Speed}\right) \times 1.1$$

- **Click OK to start the calculations**

# LET'S WALK THROUGH TOGETHER

# Knowledge Check

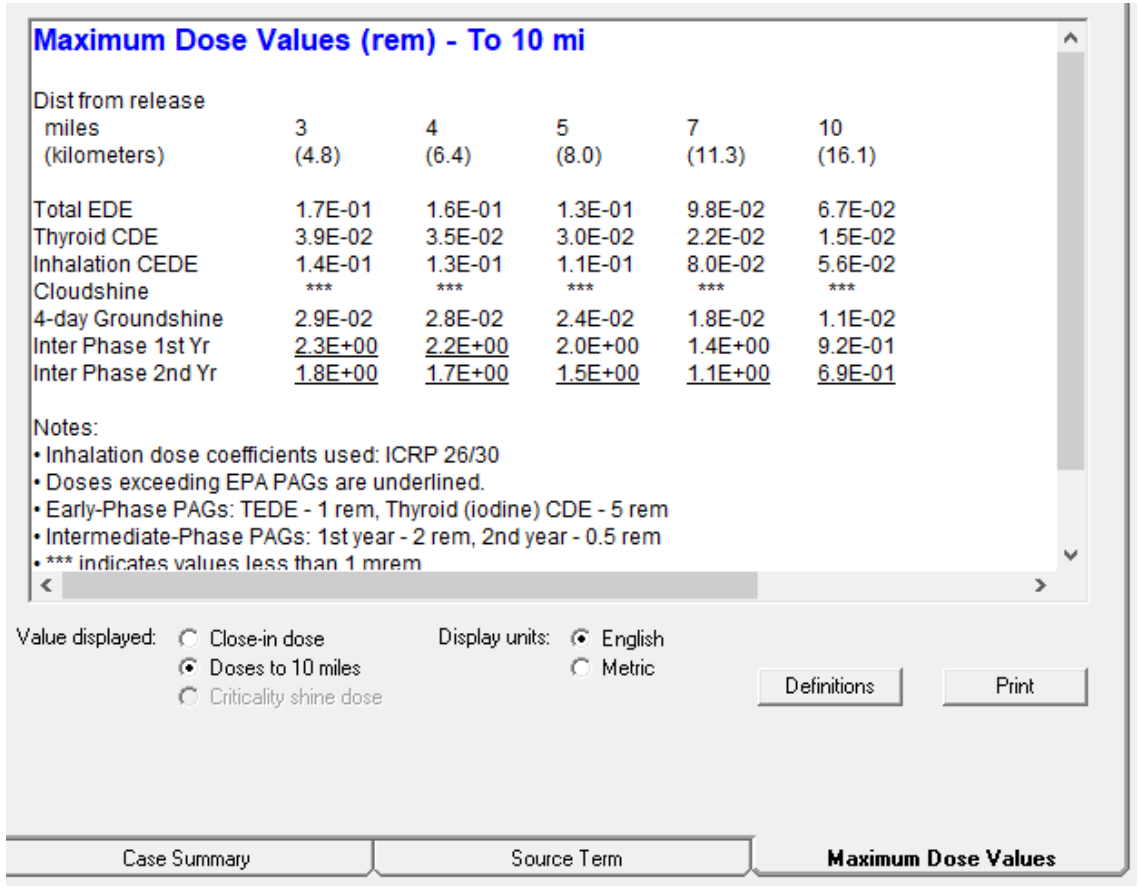
Which calculation grid has the better resolution?

- 50-mile
- 10-mile
- They have the same resolution

What would you set as the calculation duration with a 7-hour release with 5 mph winds on a 10-mile grid?

- 8 hours (RASCAL default)
- 9 hours
- 10 hours or more
- 96 hours (RASCAL max)

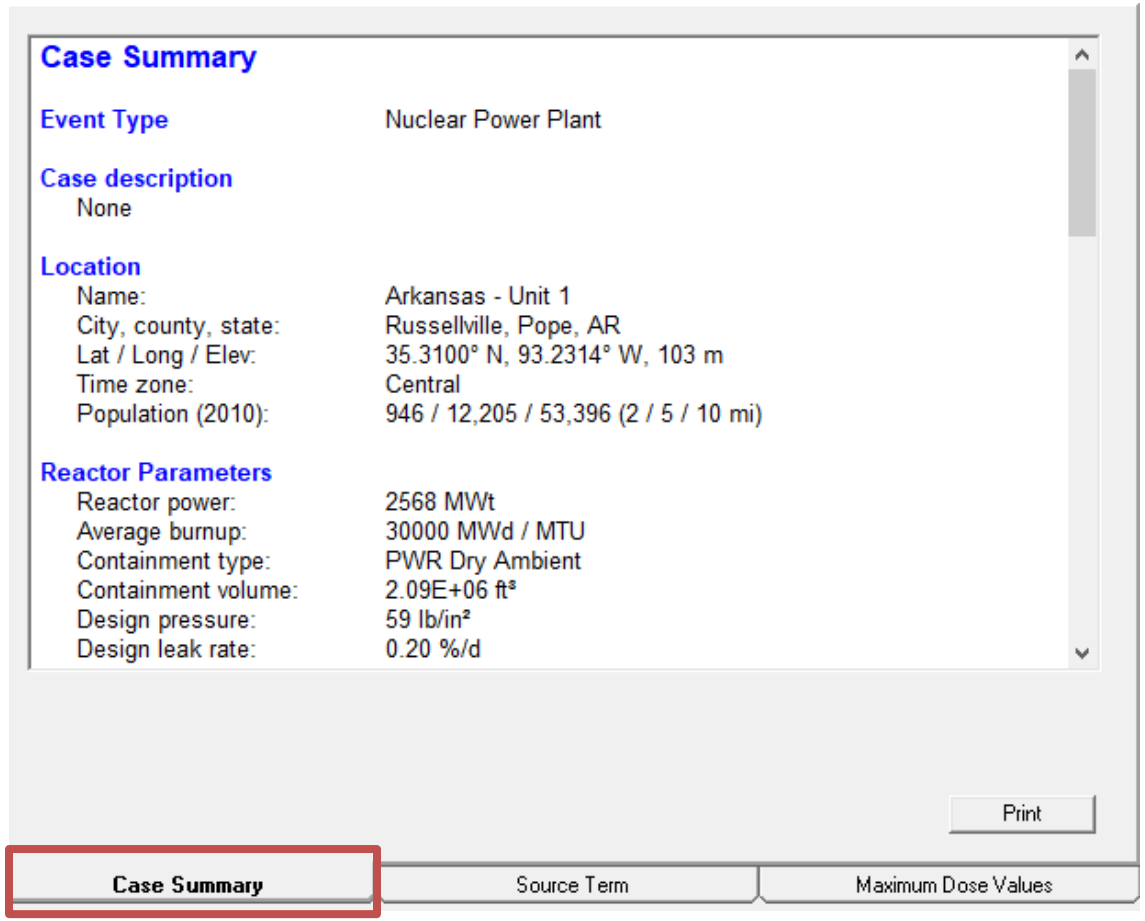
# RASCAL Results




Your results will be different than screenshot.
For discussion purposes only.

- When RASCAL is finished calculating, it shows this screen, which is just 1 of 3 tabs at the bottom
- They each contain different information and have a different purpose, let's go through them

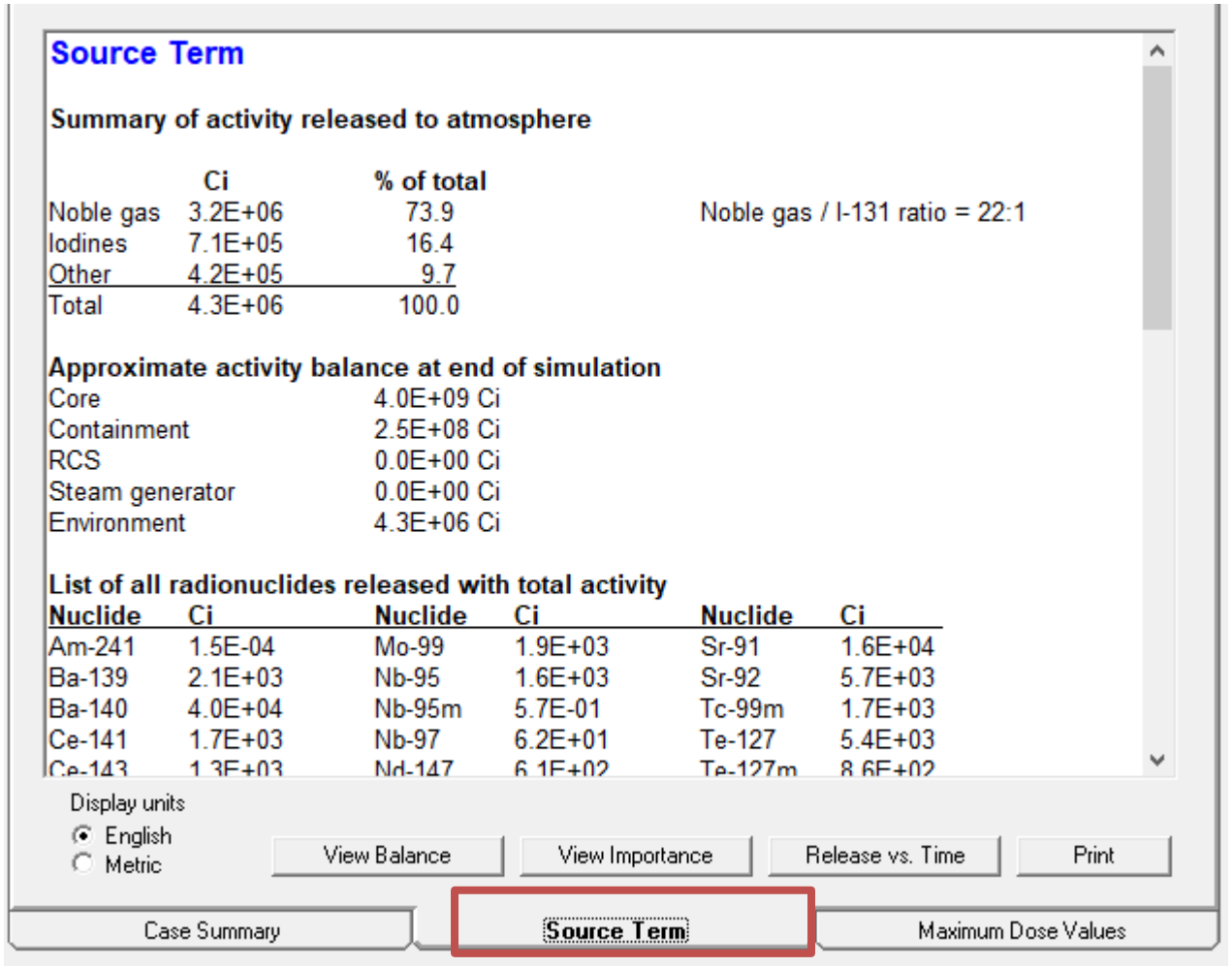
# Case Summary Tab Shows Inputs




Your results will be different than screenshot.
For discussion purposes only.

- The Case Summary tab has been populating as we added info
- You can use it as a great way to check your inputs all at once or compare inputs against other dose assessors

# Source Term Tab Shows Details for Release to Atmosphere



**Source Term**

**Summary of activity released to atmosphere**

| | Ci | % of total |
|---|---|---|
| Noble gas | 3.2E+06 | 73.9 |
| Iodines | 7.1E+05 | 16.4 |
| Other | 4.2E+05 | 9.7 |
| Total | 4.3E+06 | 100.0 |

Noble gas / I-131 ratio = 22:1

**Approximate activity balance at end of simulation**

| | |
|---|---|
| Core | 4.0E+09 Ci |
| Containment | 2.5E+08 Ci |
| RCS | 0.0E+00 Ci |
| Steam generator | 0.0E+00 Ci |
| Environment | 4.3E+06 Ci |

**List of all radionuclides released with total activity**

| Nuclide | Ci | Nuclide | Ci | Nuclide | Ci |
|---|---|---|---|---|---|
| Am-241 | 1.5E-04 | Mo-99 | 1.9E+03 | Sr-91 | 1.6E+04 |
| Ba-139 | 2.1E+03 | Nb-95 | 1.6E+03 | Sr-92 | 5.7E+03 |
| Ba-140 | 4.0E+04 | Nb-95m | 5.7E-01 | Tc-99m | 1.7E+03 |
| Ce-141 | 1.7E+03 | Nb-97 | 6.2E+01 | Te-127 | 5.4E+03 |
| Ce-143 | 1.3E+03 | Nd-147 | 6.1E+02 | Te-127m | 8.6E+02 |

Display units
English
Metric

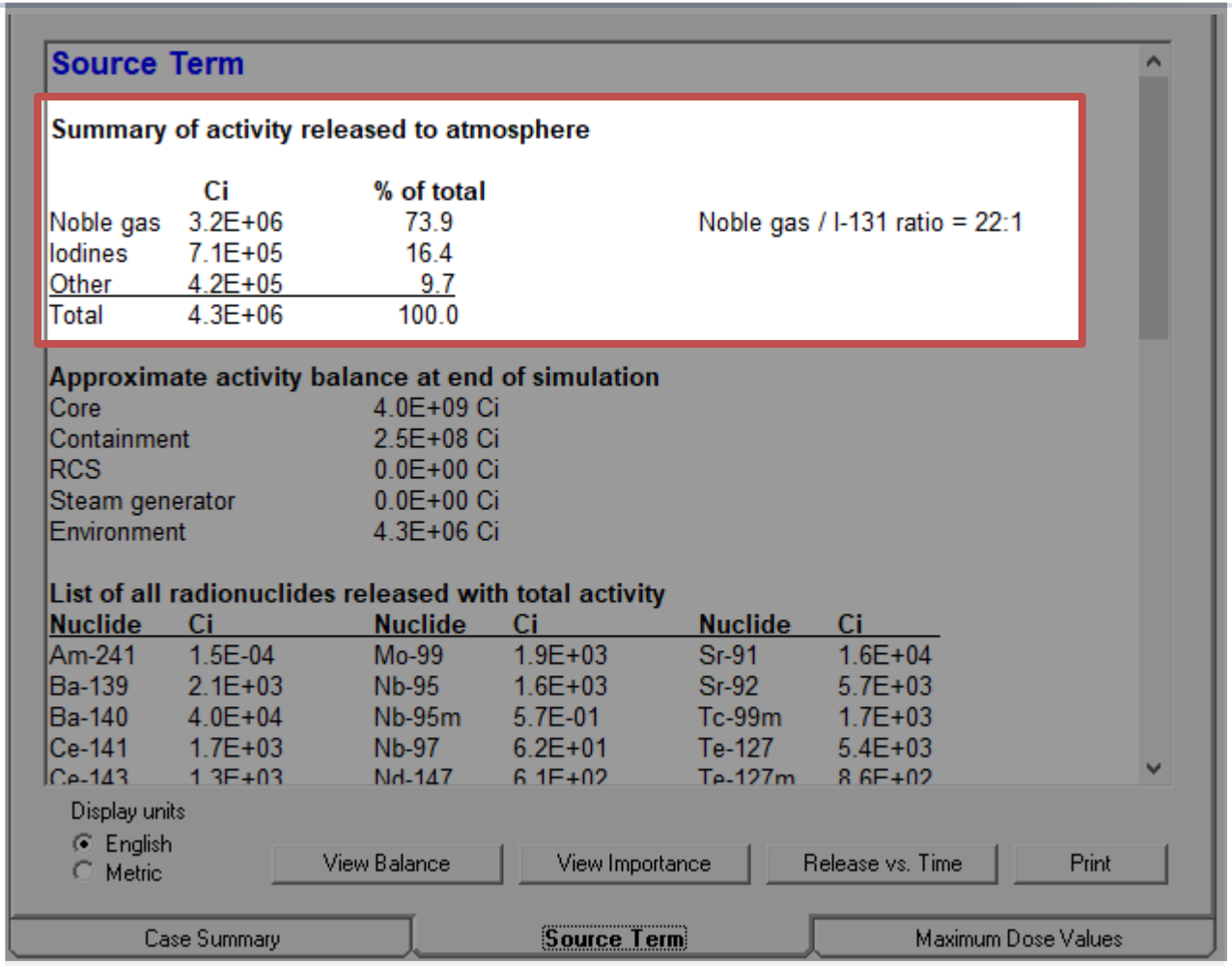
View Balance | View Importance | Release vs. Time | Print

Case Summary | Source Term | Maximum Dose Values

- Summary
- Activity Balance
- Source Term by Isotope/Time
- Nuclide Importance to Dose

Your results may be different than screenshot.
For discussion purposes only.

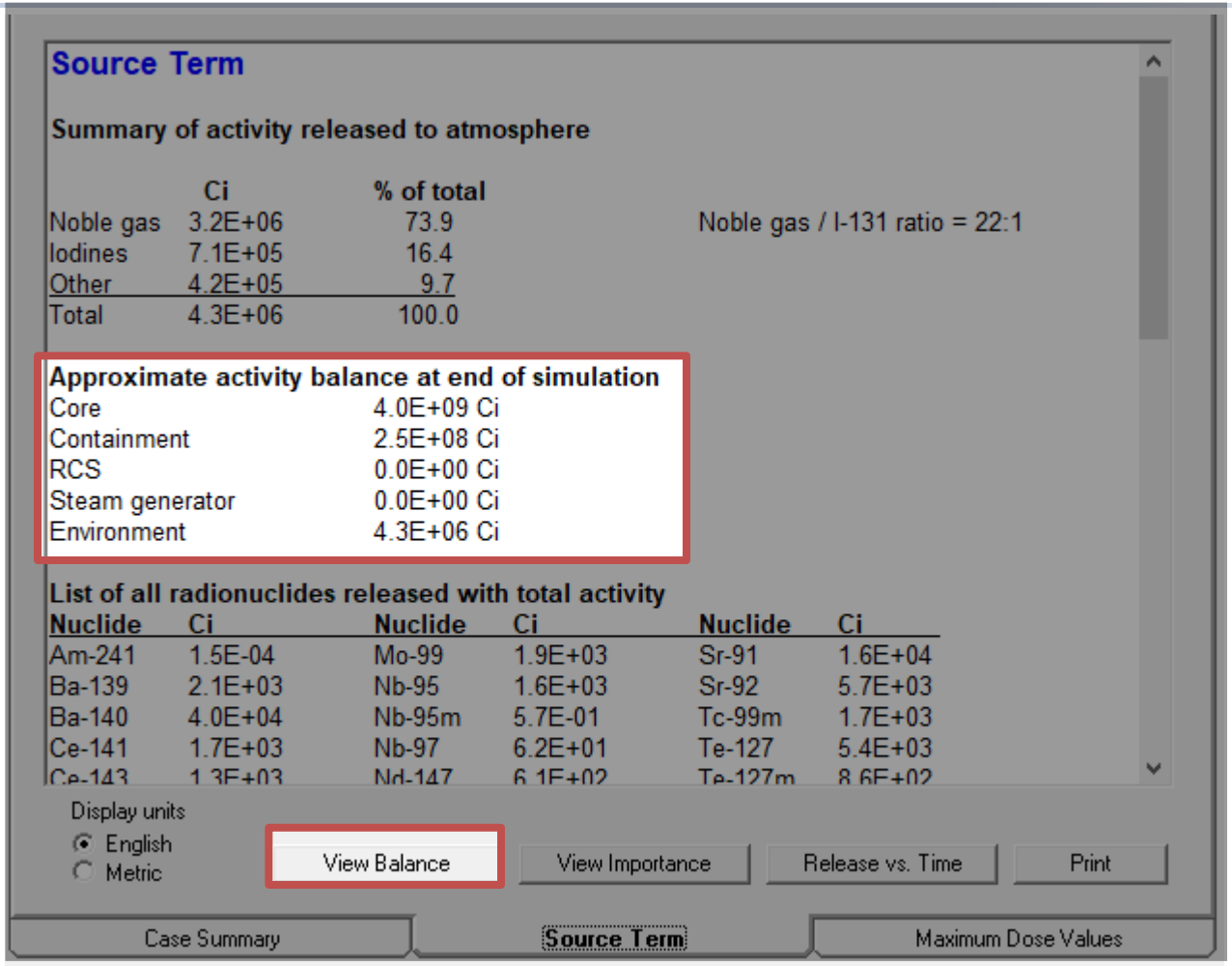
# Source Term Tab Shows Details for Release to Atmosphere




- Summary
  - Noble gas, Iodine, Particulate Group activities and percents
  - NG/I131 ratio

Your results may be different than screenshot.
For discussion purposes only.

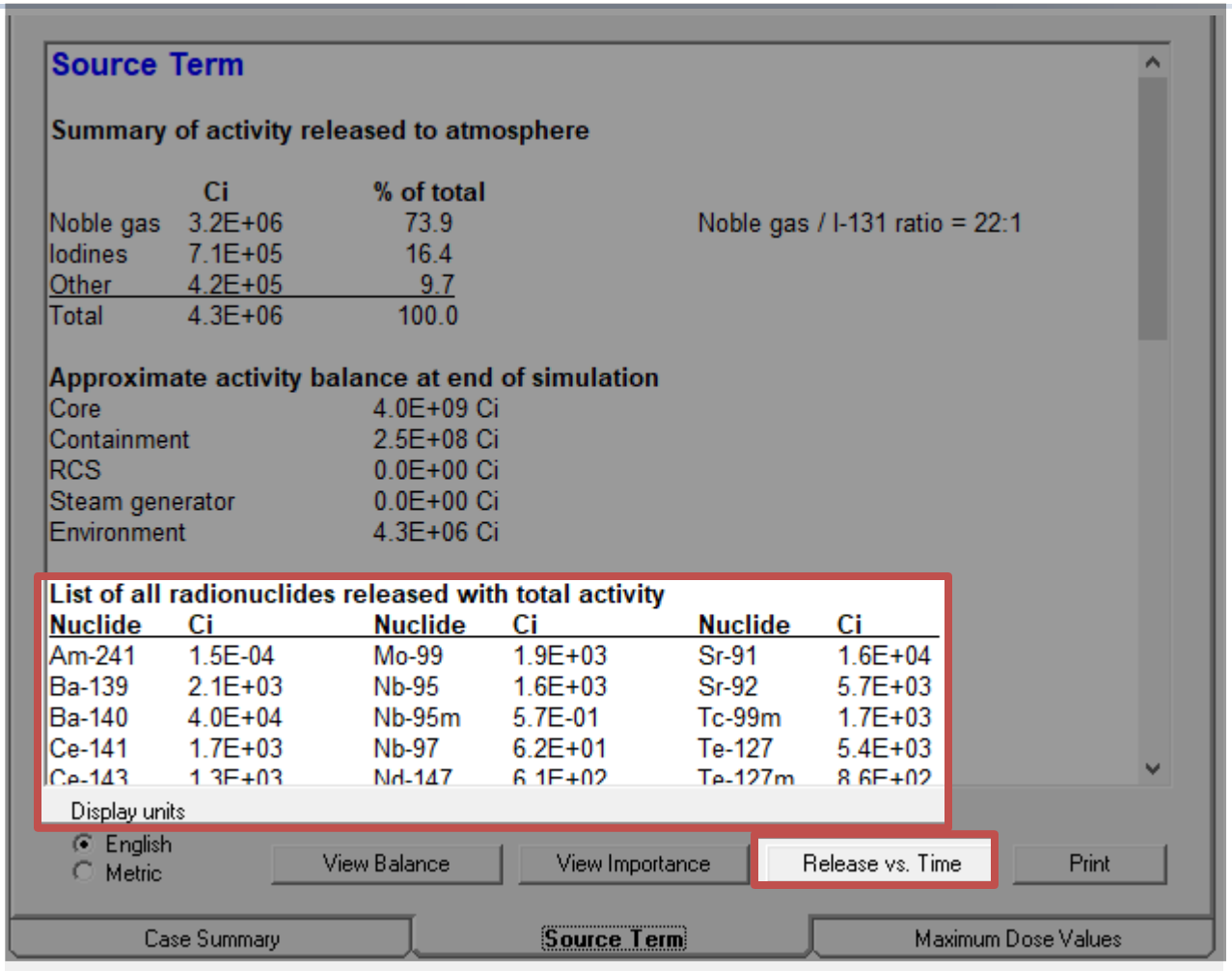
# Source Term Tab Shows Details for Release to Atmosphere




Your results may be different than screenshot.
For discussion purposes only.

- Activity Balance
  - Where nuclides are at the end of the simulation
  - Additional information and timesteps by clicking button

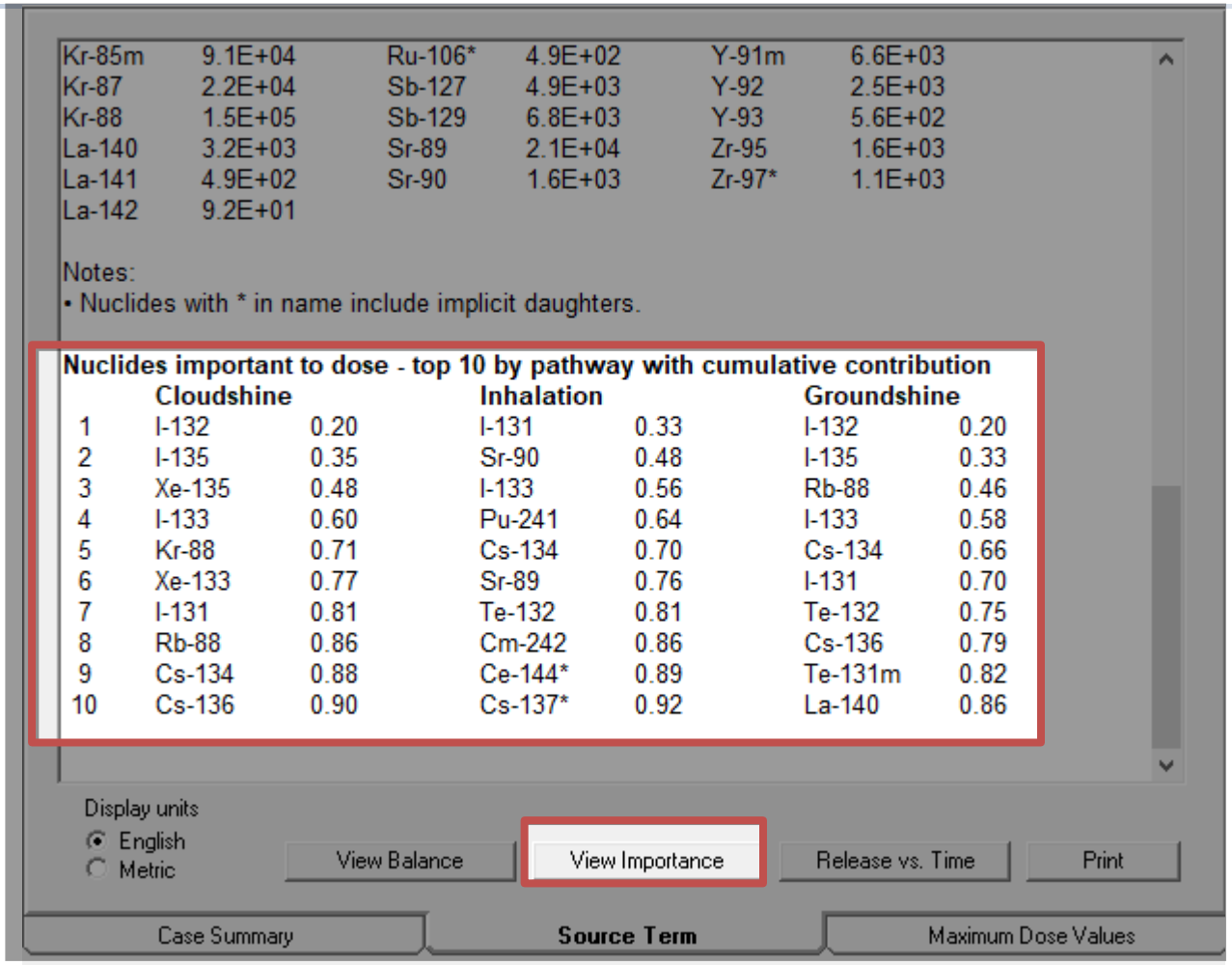
# Source Term Tab Shows Details for Release to Atmosphere




- Source Term by Isotope/Time
  - Displays amount of each nuclide released each 15-minute time step
  - Click Release vs Time to see values by timestep
    - Can be exported

Your results may be different than screenshot.
For discussion purposes only.

# Source Term Tab Shows Details for Release to Atmosphere



| | | | | | |
|---|---|---|---|---|---|
| Kr-85m | 9.1E+04 | Ru-106* | 4.9E+02 | Y-91m | 6.6E+03 |
| Kr-87 | 2.2E+04 | Sb-127 | 4.9E+03 | Y-92 | 2.5E+03 |
| Kr-88 | 1.5E+05 | Sb-129 | 6.8E+03 | Y-93 | 5.6E+02 |
| La-140 | 3.2E+03 | Sr-89 | 2.1E+04 | Zr-95 | 1.6E+03 |
| La-141 | 4.9E+02 | Sr-90 | 1.6E+03 | Zr-97* | 1.1E+03 |
| La-142 | 9.2E+01 | | | | |

Notes:
• Nuclides with * in name include implicit daughters.

**Nuclides important to dose - top 10 by pathway with cumulative contribution**

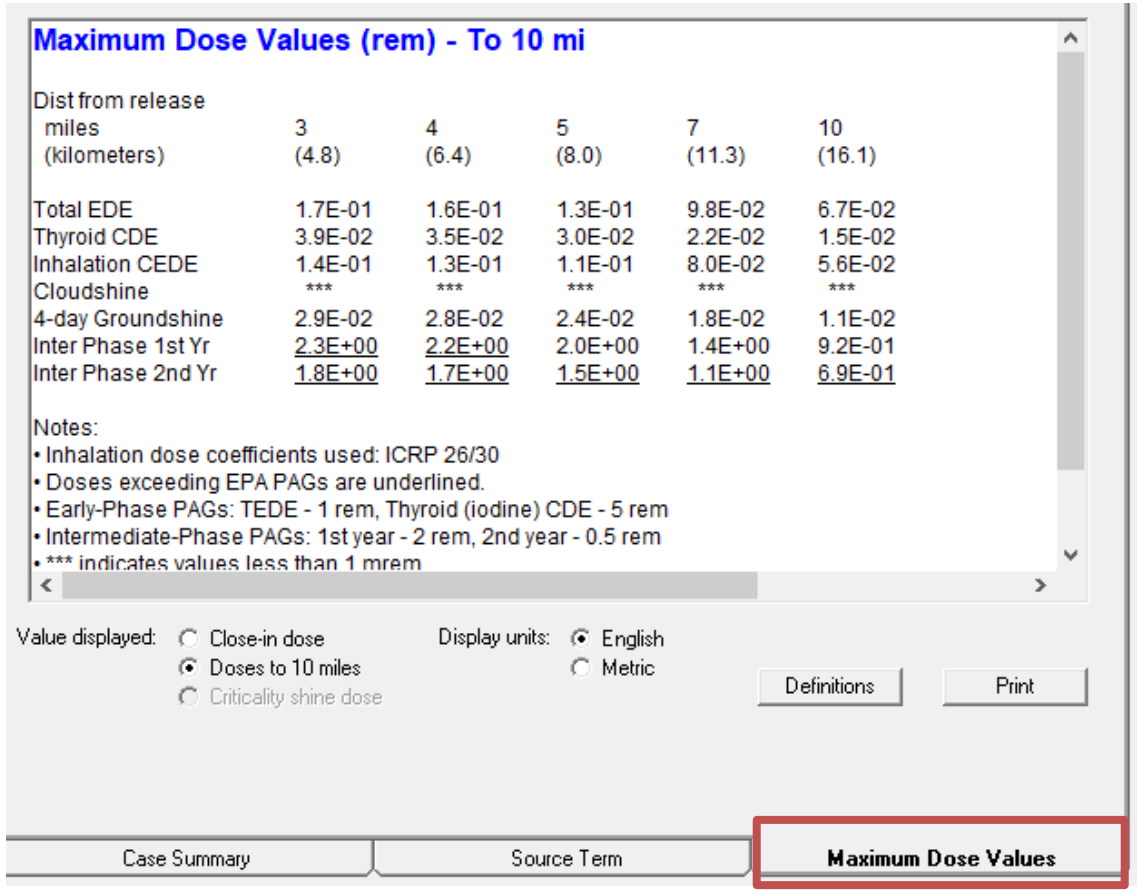
| | Cloudshine | | Inhalation | | Groundshine | |
|---|---|---|---|---|---|---|
| 1 | I-132 | 0.20 | I-131 | 0.33 | I-132 | 0.20 |
| 2 | I-135 | 0.35 | Sr-90 | 0.48 | I-135 | 0.33 |
| 3 | Xe-135 | 0.48 | I-133 | 0.56 | Rb-88 | 0.46 |
| 4 | I-133 | 0.60 | Pu-241 | 0.64 | I-133 | 0.58 |
| 5 | Kr-88 | 0.71 | Cs-134 | 0.70 | Cs-134 | 0.66 |
| 6 | Xe-133 | 0.77 | Sr-89 | 0.76 | I-131 | 0.70 |
| 7 | I-131 | 0.81 | Te-132 | 0.81 | Te-132 | 0.75 |
| 8 | Rb-88 | 0.86 | Cm-242 | 0.86 | Cs-136 | 0.79 |
| 9 | Cs-134 | 0.88 | Ce-144* | 0.89 | Te-131m | 0.82 |
| 10 | Cs-136 | 0.90 | Cs-137* | 0.92 | La-140 | 0.86 |



Your results may be different than screenshot.
For discussion purposes only.

- Nuclide Importance to Dose
  - What nuclides are contributing the most to dose
  - Separated into Cloudshine, Inhalation, and Groundshine
  - Cumulative Percents
    - Values next to each isotope are percent contribution for that nuclide plus all others above it
  - Click View Importance Button to see additional details

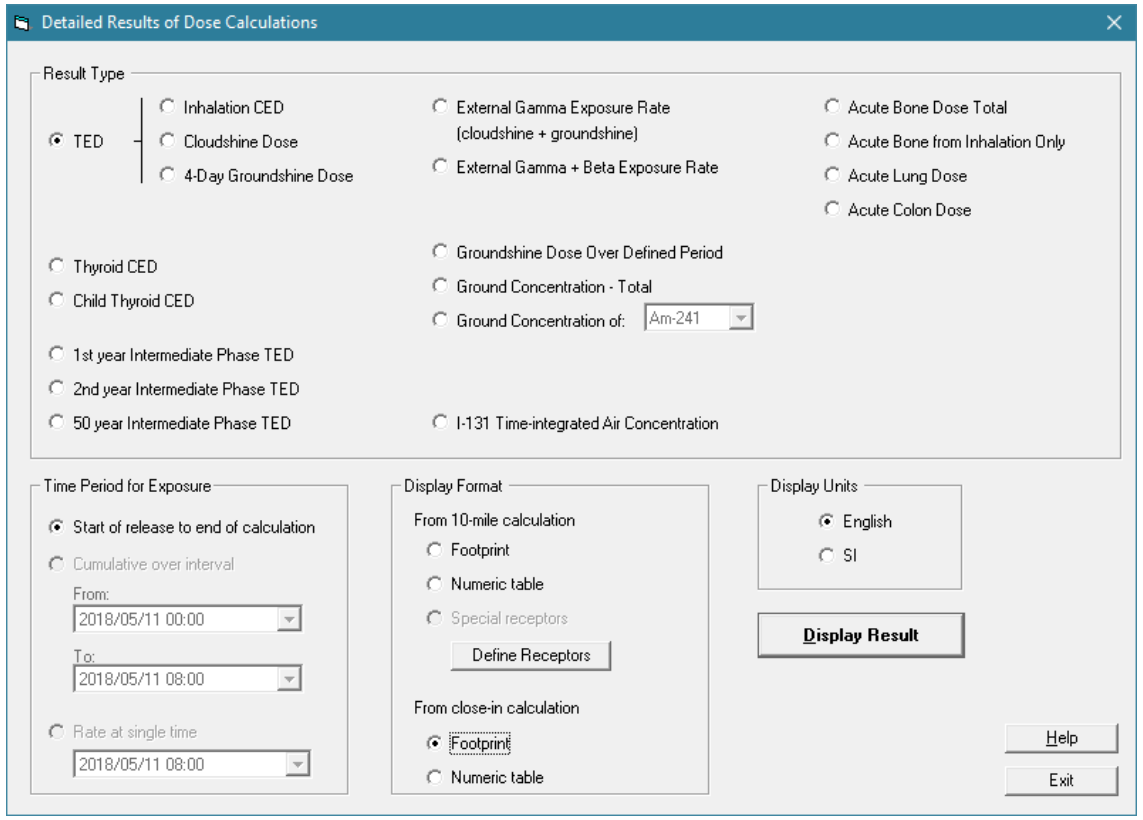
# MAX VALUES TABLE SHOWS DOSE SNAPSHOT




Your results will be different than screenshot.
For discussion purposes only.

- Summary window
  - Doses important for protective actions (TEDE, Thyroid)
  - Underlines doses exceeding PAGs
- Select distance
  - Close in vs selected “far out” model distance
- Does not show direction

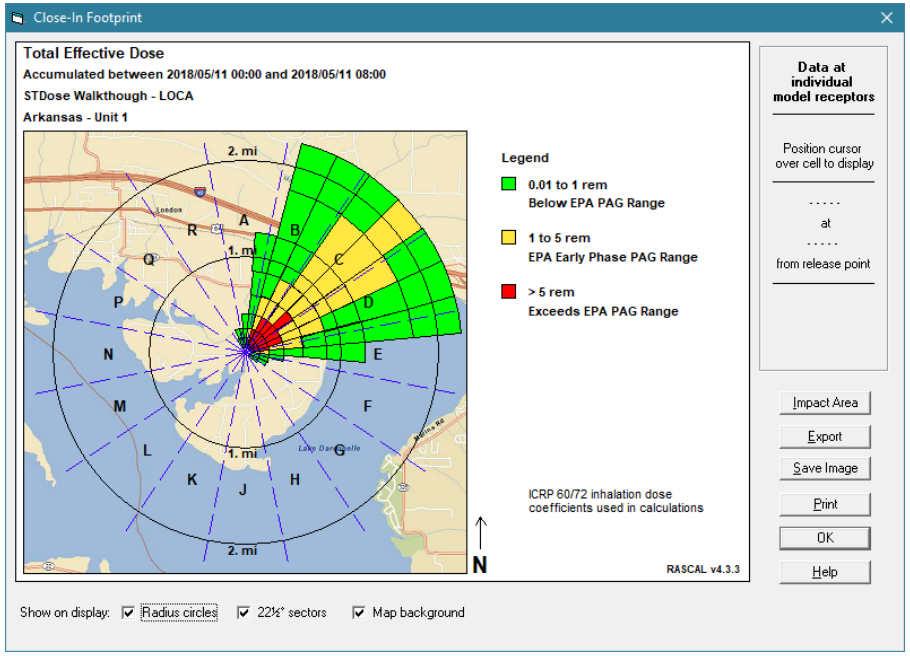
# For Additional Result Information, Click Detailed Results



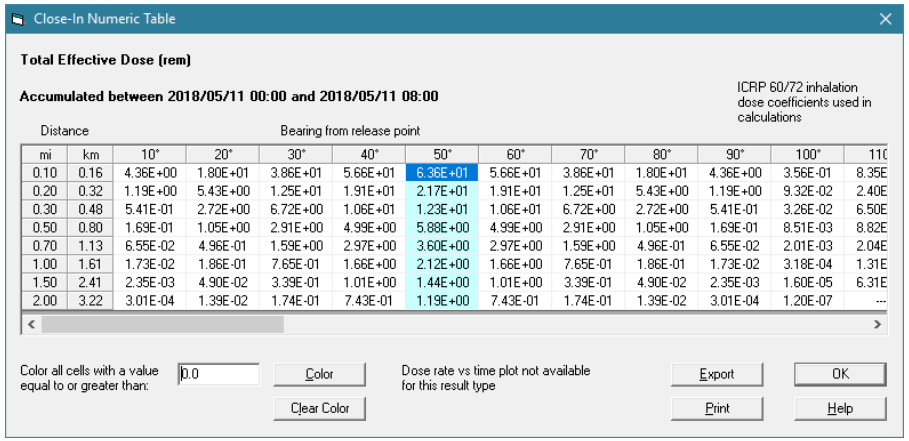

- Provides additional graphical and tabular outputs
- Result types at top
  - Dose-related
  - Deposition/Measurements
  - Acute doses
- Settings on the bottom
  - Time - cumulative or rate
  - Map/Table; Close-in or Further Out
  - Units

# Difference between Footprint and Table

- Footprint provides celled results on map
- Table provides numeric values
- Both can be exported, map can be queried, table can be filtered




Footprint

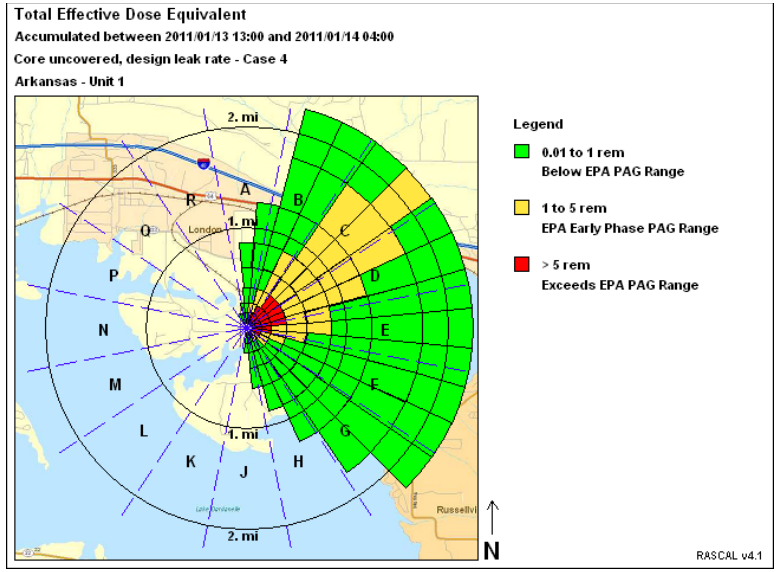



Table

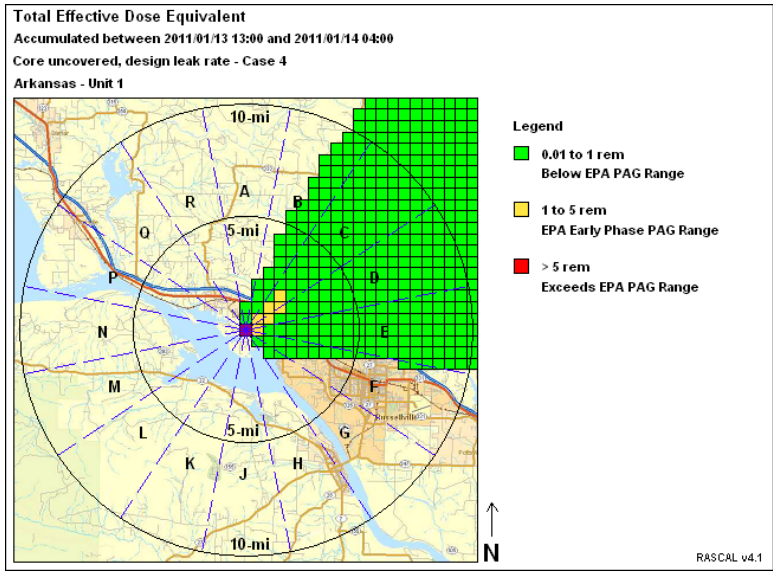
# Difference between "close in" and "Far Out"

Two ATD models are used in the calculations

- Resolution advantages
- Overlap may not line up exactly




Plume Model




Puff Model

# Your Turn to Use RASCAL


- Examine the results
  - Maximum Dose Values tab shows some doses at selected distances
  - Source Term tab show details about the atmospheric release
  - Click Details Results to see options for looking at dose on a map

# LET'S WALK THROUGH TOGETHER

# KNOWLEDGE CHECK

What is the projected TEDE (rem) at 5 miles?

- 1.4E+00
- 1.7E+00
- 3.2E+01
- None of the above values

What percentage of the release to the atmosphere is iodines?

- 0.6%
- 12.9%
- 16.4%
- None of the above values

What direction is the plume projected to travel?

- Northeast
- East
- Southeast
- Southwest

# This concludes our intro walkthrough

**You should now be able to click through RASCAL start to finish.**

**Remember that resources & training can be found at:**

**https://ramp.nrc-gateway.gov/**